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CONTENTS



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# THE POULTRY INDUSTRY OF AUSTRALIA [1]

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*Of the Department of Animal Husbandry*

WITH EIGHT TEXT FIGURES

The export products of the poultry industry in Australia consist mostly of eggs in the shell, although egg pulp and frozen poultry are now also being exported in sizeable quantities. The bulk of the export trade of Australia is with the United Kingdom.

*Extent of the industry.* Victoria is the leading poultry state of the Commonwealth, followed by New South Wales, South Australia, and Queensland in the order named. In 1937-38, the poultry population of Australia numbered about 15,128,000 head. Of the total poultry population of the country, about 88.9 per cent were chickens; 6.4 per cent were ducks; 3.7 per cent were turkeys; and only 1.0 per cent, geese. The distribution of these fowls in the different states of the Commonwealth is given in table 1 (Wilson, 1939).

Commercial poultry farms range in size from much less than one acre (4,000 sq. m.), on which as many as 1,000 layers are raised, to over 50 acres (20 Ha.) with as many as 240,000 layers. There are many small breeding flocks that have become famous all over the country. A number of the well-known stud flocks that were visited were raised only in the back yards.

*Breeds of chickens raised.* In Australia, the S. C. White Leghorn predominates. Probably as much as 75.0 per cent of all fowls raised in the Commonwealth belong to this breed. Australian S. C. White Leghorns are much heavier than those of other countries. Pullets that are just beginning to lay weigh at least 4.5 lbs. (about 2.0 kgms.); the majority of them weigh 5.5 lbs. (2.5 kgms.). It was a pleasure to handle many young pullets weighing as much as 6.0 lbs. (2.7 kgms.) at that age. They may not be phenomenally good layers as are some of those in the United States, but records of over 300 eggs are also well known in Australia. Many of the flocks visited, numbering from 1,000 to 10,000 layers or more, averaged about 200 eggs per hen a year. In New South Wales, the average production of the

[1] General contribution No. 778.

540 S. C. White Leghorn pullets entered in the Hawkesbury Agricultural College Egg-Laying Competition in 1939-40 averaged 206.8 eggs each in 50 weeks (Houghton, 1940). In Victoria, the 650 S. C. White Leghorn pullets entered in the Burnley Egg-Laying Competition averaged 199.4 eggs each in 48 weeks (Clinton, 1940).

The Australorp, a breed developed in Australia, mostly of the Black Orpington blood, is only a far second to the S. C. White Leghorn in number. According to records, Black Orpingtons were first brought to Australia from England in November, 1887. These birds were developed by one William Cook of Orpington, England, by mating Black Minorcas with Black Plymouth Rocks, and these produced black pullets with well-shaped bodies. These beautiful black pullets were later mated with Langshans, and from this mating, those produced without feathers on the shanks were used in the development of the utility Black Orpington. This history of the Black Orpington is important in tracing the history of the Australorp because, in Australia, further crosses in which the Langshans played a prominent part were made and the breed now known as the Australorp was evolved. The bird is a good winter layer and, in total production, it compares very favorably with the S. C. White Leghorns. In Victoria, the average production of the Australorps entered in the Burnley Egg-Laying Competition in 1939-1940 was 200.0 eggs in 48 weeks (Clinton, 1940). In the Hawkesbury Agricultural College Egg-Laying Competition, the Australorps entered in 1939-40 averaged 192.3 eggs each in 50 weeks (Houghton, 1940). In spite of this, the Australorp has not become very popular as yet probably because of the absence of a definite standard for the breed. Each state follows its own standard in its breeding operations. Efforts are now being made, however, to adopt one standard for the entire Commonwealth, so that there will be no confusion.

There are other breeds of poultry raised, but these do not play a prominent part in the poultry industry of the country. Among these breeds may be mentioned the Rhode Island Reds, the Langshans, bred more for egg production than for meat, the Wyandottes, and the Sussex. There are many other breeds that are raised purely for fancy purposes. The Plymouth Rocks are not raised to any extent in Australia.

*Ducks.* There is an excellent market for ducks for meat purposes in Australia. For this reason, the Muscovy has become more

popular than any other kind. Ducks are also raised for egg production but not in as big a commercial scale as in the Philippines. The Khaki Campbell and the Indian Runner breeds are the favored ones.

There is a farm near Melbourne, the Werribbee Poultry Farm, that is principally a chicken farm, but there are also six acres

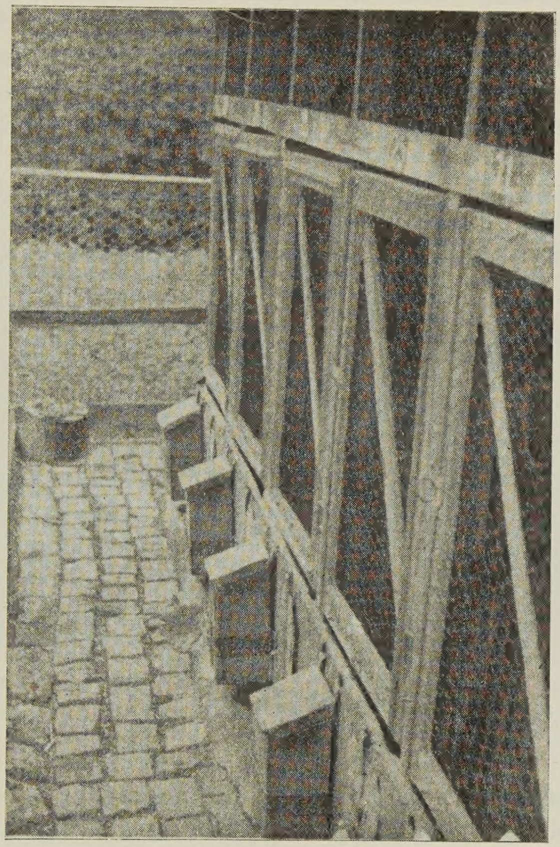

Fig. 1.—A portion of the laying pens on an intensive "back yard" poultry farm in Victoria. In this back yard, not less than 1,000 layers are being raised.

(2.4 Ha.) planted to apricots and apples, all in full bearing. Not a single good apricot, however, could be obtained from the orchard because of depredations by snails. The owner, Mr. W. Cullen, placed in the orchard 40 Indian Runner ducks, and in three months, the entire orchard was rid of snails and the ducks laid unexpectedly

well. With very little care, they laid so well that Mr. Cullen increased their number till at the time of the visit, there were about 400 layers on the place. These birds give him a good income in eggs; at the same time, they clean his orchard of snails. Now, they form a major part of the farm, bringing in a large proportion of the farm's income.

Aylesbury and Pekin ducks and their cross with Muscovies are also popular. "Mule" ducks are much sought because of the superior quality of their meat. The production of this kind, however, must necessarily be limited owing to the necessity of having two kinds of ducks to maintain on the farm instead of only one.

Fig. 2.—A flock of Australorps. These are young pullets recently placed in the laying house.

*Housing the layers.* Open-front, shed-roofed laying houses are used throughout Australia. The laying flocks are generally divided into small units of from 50 to 100 each. In Victoria, where poultry farming is much more intensively carried on than in the other states, a number of farms visited had much larger laying units. These ranged from 250 to 1,200 layers each. In such cases, "saw-tooth-roof" houses are used. In this state, too, the flocks are generally kept inside the laying houses throughout the year, as the farmers are strongly against letting their birds out on the range for fear of infection. They depend a great deal upon cod-liver oil to prevent leg weakness in the flock. Cut grass is thrown to the birds regularly every day. In New South Wales, the laying birds

are allowed on the runs and all the growing stock are given free range. On Queensland farms, the birds are out in the yards most of the time. While the problem of Philippine poultry raisers is to keep the grass down, particularly during the rainy season, in Australia, the yards where the birds are allowed are bare. Green feeds have to be grown in separate fields in order to provide a sufficient supply of these essentials all the year round.

Very few farmers use trapnests. The birds are selected on the basis of physical characters and on the qualities of the eggs produced. The poultry farmers believe that too much emphasis has been placed on the use of the trapnest in the United States and they ascribe the

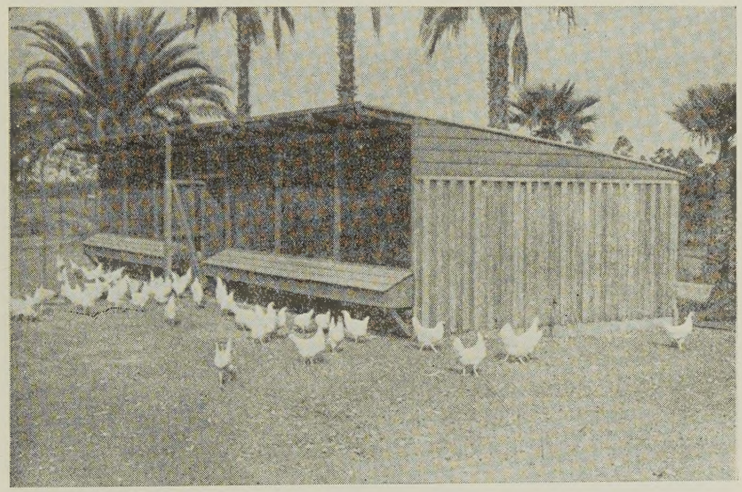

Fig. 3.—An open-front laying house in Hawkesbury Agricultural College, New South Wales. Note the nests outside.

degeneration of both size and constitutional vigor very noticeable among the United States chickens to too much reliance on this device in the selection of their breeding fowls.

The droppings board is another part of the laying house that is conspicuous by its absence in Australian laying houses. Many of the houses are provided with concrete floor, but there are also many that have nothing but dirt floor. Whatever the type of flooring used, however, the floor is covered with a thick layer of litter, mostly in the form of either chopped hay, saw dust, or rice hulls. The litter is replaced only occasionally and the old soiled one is sold for fertilizing purposes. In Victoria, the poultry farmers buy rice

hulls for use as litter at one shilling (₱0.32) a bag, when they can get it.

*Incubation.* Hatching all over Australia is done during the winter months, June, July, and August. The breeders are selected early in March and April. They are forced to molt either by withholding mash feed from them, giving them only grain for about a week, or by not giving them any water for two days. As soon as the birds stop laying, they are given the ordinary laying ration. This insures the breeders a sufficient supply of eggs for hatching even during the winter months.

The eggs are placed in the incubators in June, July, and August, and sometimes as late as September. Before the end of the breeding season, the males are withdrawn from the pens and placed in individual pens constructed for them. The farmers claim that early hatching is advantageous for the chickens produced are healthier, the pullets come into production earlier than the late hatched ones, the pullets are better able to stand the excessive heat during the summer, they make better breeders the following season, and the excess cockerels produced can be sold before the season is glutted. They think that hatching in the Philippines could be done better during October, November, and December than during later months. The chickens produced then will be big enough to stand the heat during the hot months of April and May.

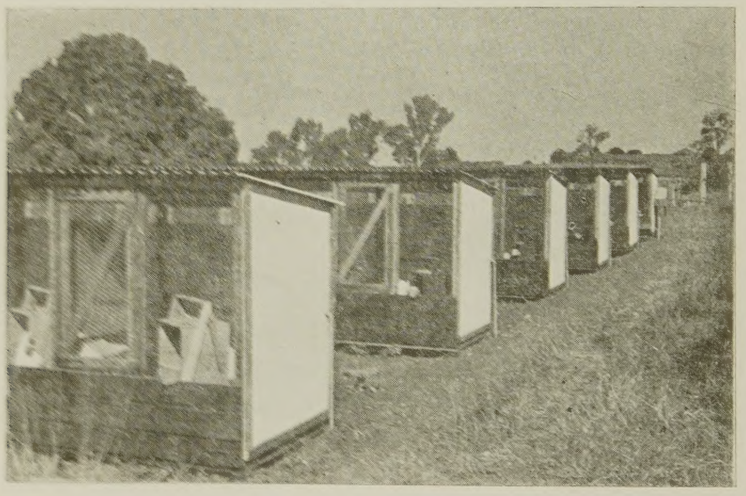

Fig. 4.—Individual testing pens in Queensland.

*Brooding.* On most commercial farms, brooding is by means of mammoth brooders heated by electricity or hot water. On some farms visited in Victoria, New South Wales, and Queensland, the brooders are heated by kerosene only. In Queensland, some poultry farms use cold brooders, and if some use heated brooders at all, the chicks are given heat only during the first fortnight after their removal from the incubator. They found that chicks raised in cold brooders, or with minimum heat, are more vigorous than those raised with artificial heat throughout the brooding period.

In most cases, the chicks are brooded in small units of about 100 chicks each. They are confined in the heated brooders for only

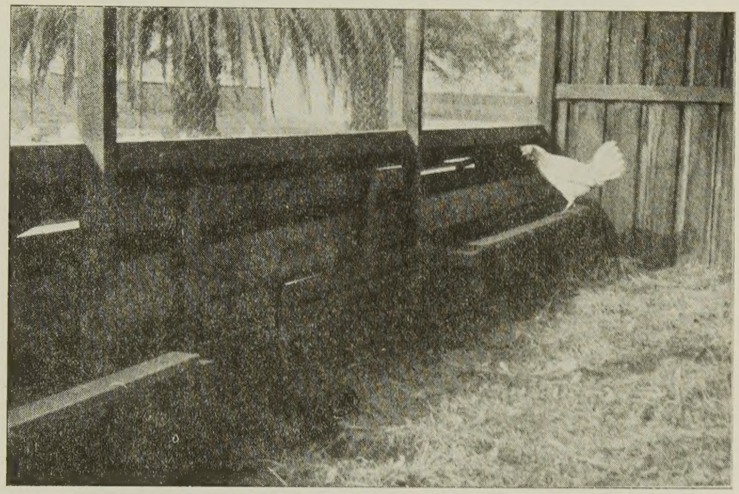

Fig. 5.—Open nests. This type of construction of nests is typical of Australian laying houses.

two or three weeks, after which they are transferred to small training compartments for another two or three weeks, depending on weather conditions. Here, the chicks are kept without being supplied with heat and are thus trained to be independent of it. The birds are then released on the range till they are rounded up for the laying houses. The flocks are culled continuously in order to save space and cut costs. Brooding mortality on most of the farms visited is unusually low. A brooding mortality of 5.0 per cent is considered high by many poultry farmers.

*Feeds.* In all rations used for chickens of all ages, wheat bran and pollard form the base feeds. Pollard is the second skin of the wheat kernel. It is a very fine feed, but in most cases, it is adul-

terated with ground chaff and stems of the grain. A typical laying ration consists of about 30.0 per cent wheat bran, 50.0 per cent wheat pollard, 10.0 per cent of either barley, oaten pollard, or maize meal, and 10.0 per cent of either meat meal or powdered buttermilk. The grain mixture consists of wheat, barley or oats, and maize in the proportion of 60-20-20. The mash feed is given either dry or wet, or wet in the morning and dry in the afternoon. On many

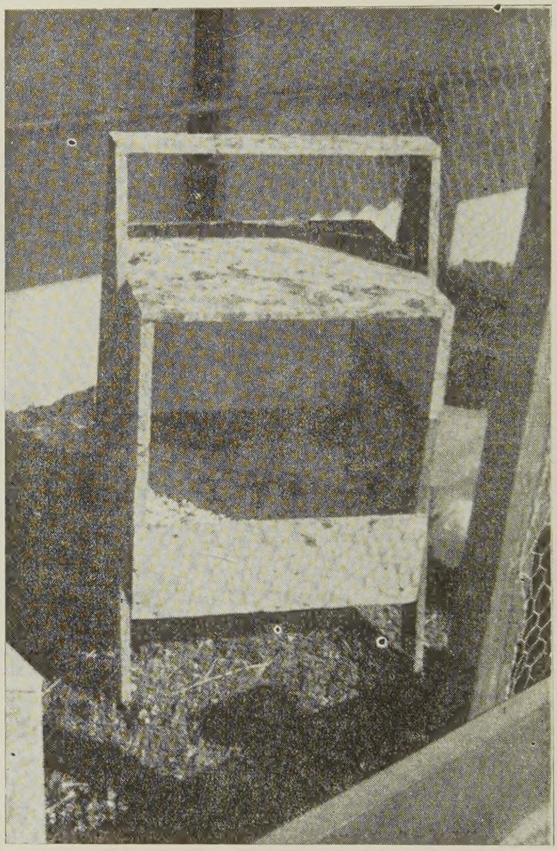

Fig. 6.—A combination roost and nest for individual laying pens.

farms, grain is fed only in the evening when it is scattered either in the yards or mixed with the litter. Green feed is usually fed around noon.

Lucerne (alfalfa) constitutes the bulk of the green stuff used for poultry feeding. Beets, rape, oats, barley, maize, millets, cabbage, cauliflower leaves, "Chou Moellier," and "Wong Bok", or

Chinese cabbage, are also grown to insure a good provision of green feed throughout the year. In New South Wales, a program of green cropping to provide a sufficient supply of green feed any time has been devised by the Department of Agriculture for the use of the poultry farmers.

Meat meal is the most common protein supplement used in the poultry rations. This consists mostly of the viscera of animals slaughtered in the abattoirs, and the carcasses of animals that have been condemned as unfit for human food. Two processes are used in the manufacture of meat meal, the dry and the steam processes. Meat meal is sold to the poultry farmers at prices ranging from

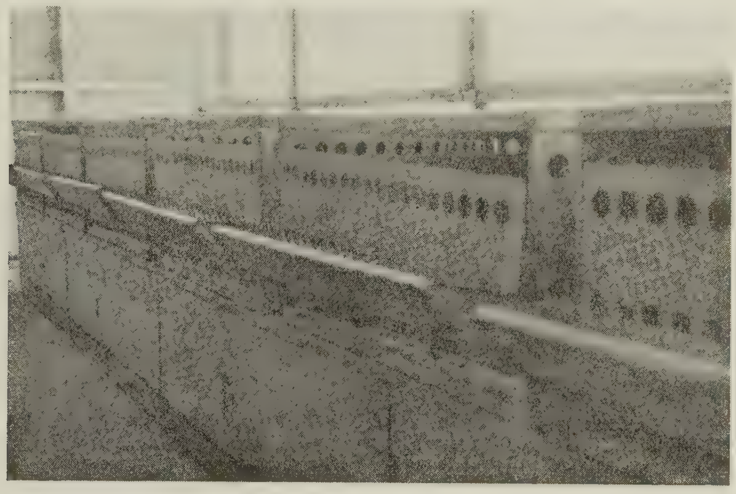

Fig. 7.—A portion of a mammoth brooder. The upper tier is used during the first two or three weeks of age of the chicks. The lower is used as the training compartment.

£8/-/- (₱52.00) to about £10/-/- (₱65.00) per ton. In the Philippines, this essential supplement to poultry rations is imported mostly from the United States and is sold in Manila at prices that are prohibitive.

In the manufacture of cheese, a considerable amount of whey is produced. By a patented low temperature-drying process, a cheese company in Melbourne dries the whey produced in its factories and sells the dried product. It is a yellowish, rather fine-particled product that has become very popular all over Australia, not only for poultry feeding but also for feeding other classes of livestock. The manufacturers claim that it is more than a mere

evaporated milk powder, and that it is the most perfect milk sugar food available for animals.

*Distribution of egg production.* Probably because of the country's mild climate, the extremes in the normal egg production curve observed in the north temperate poultry-producing countries are not experienced in Australia. In spite of the fact that artificial illumination, now commonly used in the north temperate countries to increase the egg production during the winter months, is not commonly employed in Australia, winter production in this country is fairly high. The poultry year starts on April 1 with a fairly low egg production because the flocks are just beginning to lay. This


Fig. 8.—The Poultry Farmers Co-operative Society, Ltd. of Brisbane, Queensland.

production, however, gradually rises through the winter months, June, July, and August, till the peak of production is reached either in September or October, whence it gradually decreases again till the end of the poultry year on March 31. The distribution of the egg production of the birds entered in the Burnley Egg-Lying Competition in Victoria and that of those entered in the Hawkesbury Agricultural College Egg-Laying Competition in New South Wales were studied. The figures obtained are given in table 2. (Clinton, 1940; Houghton, 1940).

*Marketing of eggs.* The poultry producers of Australia do not have to worry about the marketing of the eggs that they produce,

although they now produce many more eggs than can be consumed in Australian homes. All the excess production of both poultry and eggs is taken care of in the United Kingdom where these products can enter duty free. The eggs are shipped to the London markets on consignment, and the returns are dependent upon the London prices at the time of sale. The export season is most active from September to January, and sometimes eggs are exported even as early as August and as late as February or March. Thus, the Australian egg market is favored not only by the preferential overseas market but also by the low supply of home-produced eggs in the United Kingdom during the export season; hence the London prices are nearly twice as high then as during the other seasons of the year. The net returns from eggs exported to the United Kingdom rarely exceed 1 s. (₱0.32) a dozen.

The marketing of eggs in Australia is handled by the Egg Marketing Board. The Egg Marketing Board is only one of many such Boards in the Commonwealth, as each primary product has its own Board. In Queensland alone, there are no less than thirteen of these Boards, for in addition to the Egg Marketing Board, there are Boards for arrow-root, maize, barley, butter, canary seed, cheese, cotton, pigs, peanut, and other products. The composition and operation of these Boards are essentially the same in all the states of the Commonwealth. In all cases, the majority members of the Board are elected by the producers and the minority, nominated by the State Government. For instance, in Victoria, the Egg and Egg Pulp Marketing Board, which became operative only in 1937, is composed of five members, four of whom are elected by the producers from among themselves, and only one is nominated by the State Government. In New South Wales, the Egg Marketing Board commenced operations in 1929; it consists of three members elected by the producers and two appointed by the Government. In Queensland, where the Egg Marketing Board has been in operation since 1923, the producers elect five members of the Board and the Government appoints one. Of all the Egg Marketing Boards, that of Queensland probably is the best conducted. In Victoria, there is a strong agitation to abolish the Egg and Egg Pulp Marketing Board as the producers claim that it is not doing anything for them. By law, the Board may be abolished upon the vote of the members.

The definition of "producers" who can vote as provided for by law differs slightly in different states. For instance, in Victoria, a farmer raising 12 adult females must be registered with the Board;

if he has 25 or more layers, he must sell his products through the Board, but he becomes a voting member only if he raises 150 layers. In New South Wales, farmers residing within the Board's jurisdiction and raising 20 fowls of producing age, are required to sell their produce through the Egg Board, while in Queensland, the minimum requirement is 50 domestic fowls, that is, domesticated hens, turkeys, ducks, geese, or guinea fowls.

An "equalization levy" of 1 d. (approximately ₱0.027) per dozen eggs sold is generally charged and the amount collected is pooled. This fund is used to guarantee to the producer a reasonable price of eggs fixed by the Board. In addition to this pool charge, smaller levies are collected to defray working expenses. Eggs may also be sold to agents only if permitted by the Board. Eggs thus sold are also subject to the pool charges imposed by law. Eggs that are consumed in the home and those that are used for hatching are not charged the equalization levy or the other levies imposed by the Egg Marketing Board.

*The Poultry Farmer's Co-operative Society, Ltd.* In connection with the co-operative marketing of eggs in Australia, mention should be made of the Poultry Farmer's Cò-operative Society, Ltd. of Brisbane, Queensland, an organization that, although not engaged in the buying and selling of poultry and eggs, helps the poultry farmers in that vicinity in the purchase of feed and other poultrymen's needs on a co-operative basis. The shares are £1/-/- (₱6.50) each and to derive the benefits of full membership, one must own from three to one hundred shares. It was formed in July, 1921, with a total share capital amounting to only £514 (₱3,341.00). On December 31, 1939, its share capital totalled £18,686 (₱121,495), and it did a business amounting to £289,132 (₱1,879,358) after deducting the dividends on the share capital and the rebates on purchases by the members. The society pays a 5 per cent annual dividend on the share capital. The year 1939 was the eighth in succession in which the rebate on the purchases of the members exceeded 7.5 per cent.

The society now has its own commodious building. It manufactures its own complete line of prepared feeds for poultry and livestock. It has its own grinders and feed mixers and a chemical laboratory where the feeds are tested to insure their high quality. It employs an expert who goes out and helps the poultry farmers in breeding, rearing, and feeding, in disease control, and the care and management of all other classes of livestock. In addition, the

society handles and does a big business in other requisites of poultry farmers—fertilizers, seeds, stock feeds, hardware, shoes, groceries, and in fact, anything that a poultry farmer and his family may need both on the farm and in the home.

*Diseases.* An excellent indication of the high constitution of the fowls of Australia is the very low mortality of the flocks. On the farms, flock mortalities seldom exceed 5.0 per cent a year. Of the 656 pullets entered in the Burnley Egg-Laying Competition in Victoria in 1938-1939, only 7.6 per cent died (Clinton, 1940). During the ten year period, 1927-28 to 1936-37, the mortality in this contest ranged from only 4.2 per cent in 1927-28 to 8.9 per cent in 1935-36 (Anon., 1937). In the Hawkesbury Agricultural College Egg-Laying Competition in New South Wales in which 540 pullets were entered in 1938-39, the mortality among the light breeds, S. C. White Leghorn, was only 5.8 per cent; and that among the heavy breeds, mostly Australorps, 11.0 per cent. The average mortality in the entire contest during the year, however, was only 7.8 per cent (Houghton, 1940).

Major poultry diseases are not known in Australia. In spite of the fact that the laying houses are nearly as open as those in this country, the flocks are unusually free from cold and roup even during the cold winter months. A prolonged hot spell is the only fear of the poultry raisers in Australia. During such periods, many of the birds suffer from heat stroke.

Some years ago, the Newcastle disease of fowls appeared in Victoria. This disease was wiped out of the state by instituting very drastic measures. All transport of birds and eggs was stopped; and on farms where the disease appeared, all fowls were killed. The eggs produced on the farms had to be certified as free from contamination before these could be shipped. The disease disappeared from the state after a little over 50,000 fowls had been killed. And the farmers were not compensated!

*Research work in poultry.* Very little research work is being done for the development of the poultry industry in Australia. Most of the practices on poultry farms are based upon results of observations made in other poultry raising countries, mostly in the Northern Hemisphere. The ex-poultry expert of one of the most outstanding poultry states of the Commonwealth remarked that the poultry farmers of Australia are very gullible. They follow whatever other people say is good for their poultry, whether or not it has been

tried under Australian conditions. The poultry farmers deplore the apparent lack of interest of both the Commonwealth and State Government in the welfare of the poultry industry. One poultry authority informed the writer that if one asks for £500 (₱3,250) to be used for research in cereal or livestock, he can get the amount much more easily than if he asked for only £5 (₱32) for research in poultry. The poultry farmers, in spite of this lukewarm encouragement, are fairly advanced in their practices.

SUMMARY

1. The poultry industry of Australia is an important factor in the agricultural industry of the country. Victoria is the most important poultry state, followed by New South Wales, South Australia, and Queensland.

2. The S. C. White Leghorn is the most popular fowl in Australia, followed by the Australorp. The Australorp compares very favorably with the S. C. White Leghorn in egg production. It is a better winter layer than the Leghorn.

3. Ducks are raised only in small numbers.

4. The layers are housed in open-front, shed-roofed houses. In Victoria, most of the layers are kept in the laying houses throughout the year. In both New South Wales and Queensland, the layers are allowed a wide run.

5. Very few farmers use the trapnest. The droppings board is conspicuous by its absence in Australia poultry houses.

6. Incubation is done during the winter months.

7. Artificial heat is used to a very limited extent in the brooding of the chicks.

8. The layers are selected mostly on the basis of physical characters and on the quality of the eggs that they produce.

9. Wheat bran and pollard form the base of all poultry rations in Australia.

10. The extremes in the annual egg production curve observed in the north temperate poultry producing countries are not experienced in Australia.

11. Egg marketing in Australia is handled by the Egg Marketing Board. The Australian egg market is favored not only by the preferential overseas market in London, but also by the low supply of home-produced eggs in the United Kingdom during the export season in Australia.

12. Major poultry diseases are not known in Australia. A mortality of 5.0 per cent a year is considered high on most Australian poultry farms.

13. Very little research work is being done for the development of the poultry industry in Australia.

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TABLE 1

*Number and distribution of the principal kinds of poultry in Australia in 1937-38* [a]

| STATE | CHICKENS | DUCKS | CEESE | TURKEYS |
|---|---|---|---|---|
| New South Wales | 5,052,000 | 191,000 | 25,000 | 211,000 |
| Victoria [b] | 5,497,000 | 293,000 | 39,000 | 114,000 |
| Queensland | 1,147,000 | 41,000 | 5,000 | 16,000 |
| South Australia | 2,010,000 | 43,000 | 16,000 | 49,000 |
| Western Australia | 1,203,000 | 29,000 | 2,000 | 20,000 |
| Tasmania [c] | 450,000 | 35,000 | 10,000 | 10,000 |
| Total | 14,359,000 | 632,000 | 97,000 | 420,000 |

[a] No figures were available for pigeons.
[b] Figures are as those of June 30, 1933.
[c] Estimated.

TABLE 2

*Distribution of egg production*

| MONTH | VICTORIA | | NEW SOUTH WALES | |
|---|---|---|---|---|
| | Light [a] | Heavy [b] | Light [a] | Heavy [c] |
| | *per cent* | *per cent* | *per cent* | *per cent* |
| April | 43.2 | 47.7 | 39.7 | 42.6 |
| May | 37.2 | 51.3 | 54.3 | 58.4 |
| June | 39.7 | 51.6 | 50.0 | 59.0 |
| July | 48.5 | 56.0 | 58.2 | 65.0 |
| August | 61.0 | 69.5 | 68.7 | 70.0 |
| September | 73.3 | 74.0 | 73.0 | 69.9 |
| October | 72.8 | 73.2 | 71.0 | 62.5 |
| November | 70.2 | 62.3 | 69.0 | 54.0 |
| December | 66.5 | 57.0 | 61.3 | 47.0 |
| January | 65.0 | 52.2 | 57.3 | 40.0 |
| February | 60.2 | 54.5 | 50.6 | 44.2 |
| March | — | — | 46.0 | 44.5 |

[a] S. C. White Leghorn.
[b] Australorp.
[c] Mixture of Australorp, Rhode Island Red, and Langshan, mostly Australorp.

# EFFECTS OF VARYING AMOUNTS OF AMMONIUM SULFATE UPON YIELD, RATE OF MATURITY, AND SIZE OF GRAIN OF RICE GROWN ON LIPA CLAY LOAM [1]

Bhakdi Lusanandana

WITH ONE TEXT FIGURE

Libatique (1931) found that the roots of the rice plants grown in Lipa clay loam and supplied with ammonium sulfate were much more numerous but shorter than those of the control. He also found that the yield of top and the intensity of the green color of the leaves increased with the amount of the fertilizer used. Soriano (1934) found that the chlorophyll content of the leaves increased with the amount of the fertilizer used and decreased with the age of the plant.

Talamisan (1938) added superphosphate with ammonium sulfate to the soil and found that the presence of superphosphate was ineffective in preventing the uneven ripening of grains caused by the heavy application of ammonium sulfate.

Juliano and Aldama (1937) found that an average of from two to five days was needed for all the flowers of rice in a panicle to open, and that the active anthesis took place from 9 a.m. to 11 a.m. on bright sunny days and as late as 1 or 2 p.m. on cloudy days. Apaoan (1939) observed that the maturation of the rice grains took place as early as twelve days from anthesis. Rice grains of the variety K.74 were found by Parthasarathy (1937) to mature in eighteen days after flowering.

When the volumes of hundred-grain samples from rice plants grown in the shade and those grown in the open were compared, a significant decrease in volume was noted by Apaoan (1939) in the former. The same author obtained a significant increase in length, breadth, and thickness of grains from rice plants grown in the open when compared with those from rice plants grown in the shade. Capinpin and Punyasingh (1938) found the length of unhulled grains to be the least variable, while Juliano (1938) and Apaoan (1939) reported the length of the hulled grains to be the least variable; and the thickness, the most variable.

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[1] Experiment Station contribution No. 1419. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

### *Objects of the present study*

The objects of this study were to determine the effects of varying amounts of ammonium sulfate upon (*a*) the rate of flowering, (*b*) the rate of maturity, size, and yield of grains of an upland rice grown on Lipa clay loam in pots.

### *Time and place of this study*

The culture was conducted in the experimental yard of the Department of Agricultural Botany from August 6 to November 15, 1938. Supplementary observations were made in the laboratory from November 15, 1938, to May 15, 1939.

## MATERIALS AND METHODS

### *Plant*

Upland rice plants, variety Inintiw, were used. The seeds obtained from a plant grown in a pot were soaked in water for twenty-four hours and then sown on August 6, 1938, in cans containing Lipa clay loam. Six seeds were planted in each pot. On August 10, 1938, when about four centimeters high, the seedlings were thinned and only two which were healthy and uniform in growth were allowed to continue to grow in each pot.

### *Soil*

The soil, Lipa clay loam, was taken from a vacant lot behind the Administration Building of the College. This soil was analyzed by the Department of Agricultural Chemistry and found to contain 0.13 per cent N, 0.20 per cent $P_2O_5$ and 0.37 per cent $K_2O$. A sufficient quantity of the soil was pulverized, sieved, and thoroughly mixed. About eighteen kilograms of the soil were placed in each pot.

### *Cultures and fertilizer*

The fertilizer used was ammonium sulfate; it contained 20.6 per cent of N. It was added to the soil at the time of planting at the rates varying from 0 to as high as 13.2 grams per pot.

The experiment was carried on in one set of eleven cultures; each culture was replicated six times, making a total of sixty-six pots.

### *Care of cultures*

The cultures were exposed to sun and rain. They were cultivated and weeded as often as needed. Watering was done from time

to time when there was no rain. During the flowering period, typhoons occurred several times but they were not serious enough to damage the plants.

## EXPERIMENTS AND RESULTS

### *Description of the experiment*

The cultures were started on August 6, 1938, and harvested on November 15 of the same year, thus covering a period of 102 days. Eleven different cultures were run simultaneously. Ten cultures received varying amounts of ammonium sulfate, and one culture served as control. The experimental data obtained are given as averages per hill in table 1. The rates of flowering and maturity of grains are shown as total of each culture in tables 2 and 3. Tables 4 and 5 show the size of unhulled and hulled grains, respectively.

### *Criteria of results*

The criteria of results used were as follows:

*Color of the leaves.* The color of the second leaf from the flag of each plant was compared with the color charts of Ridgway (1912). The observation was made every three days from the time the first panicle of the set emerged from the flag on October 11, 1938, till the time of harvest.

*Date of flowering.* The number of panicles fully emerged from the flags of each hill was recorded at two-day intervals. The panicles were labeled with paper tags to make possible the identification of the ages of the panicles. The observation on flowering ended on November 4, 1938, covering a period of twenty-five days for the whole set of cultures. The data obtained from every hill in the same culture were added together; thus the data obtained represent the number of inflorescences that emerged from the culture. The period from date of appearance of the first to the appearance of the last inflorescence in each culture represents the maximum period of flowering of the culture.

*Maturity of grains.* This was indicated by the yellow or straw-color of the grains. The number of mature grains on each panicle was recorded at three-day intervals. The observation lasted from October 25, 1938, to the time of harvest. The maturity of grains at each interval is reported as the total number of grains that ma-

tured in each culture. The whole period of maturity of the grains lasted twenty-two days.

*Number of bearing culms.* The bearing culms in each pot were counted at the time of flowering. The data obtained are expressed both as the total number of bearing culms produced from each culture and as the average number of bearing culms per hill.

*Number of filled and empty grains.* At harvest time, the panicles were gathered from the different hills and placed separately in paper bags, properly labeled. The full grains and empty grains from each panicle were then separated and their numbers recorded. The empty grains were discarded and the filled grains were used in the measuremnt of size and volume. The averages of the numbers of full and empty grains per hill were then found.

*Size of grains.* A sample of fifty grains was taken at random from the harvest of each hill. The length, breadth, and thickness of the grains in each sample were measured with a micrometer caliper. Then they were hulled and the three dimensions of the hulled grains were again measured. After the measurement, the hulled grains from each sample were saved and kept in a small properly labeled paper bag.

*Volume of grains.* The volumes of the 50-hulled-grain samples were determined by the water displacement method, followed by Apaoan (1939). A microburette was filled with water to a certain mark, and the sample was introduced into it. The volume of the water which rose from the initial mark was taken as the volume of the sample. Care was taken to avoid any air bubble adhering to the grains. The volumes of the samples from each culture were averaged and are shown in table 1.

## DISCUSSION OF RESULTS

### *Effects on yield of grains*

In all cases, the number of bearing culms of the fertilized plants was markedly greater than that of the control (table 1). There was a continuous increase in the number of the bearing culms in the fertilized cultures until the rate of application of the fertilizer reached 9.24 grams per pot. Further increase in the amount of ammonium sulfate gave a slight decline in the number of bearing culms produced. But why culture X, which received the highest application of the fertilizer, suddenly produced a marked increase in the number of bearing culms cannot now be explained. It is certain, how-

ever, that the increase in the number of bearing culms was accompanied by a material decrease in the number of grains. The panicles were rather small.

The number of filled grains increased with the increase in the amount of the fertilizer used up to 10.56 grams; thence gradual de-

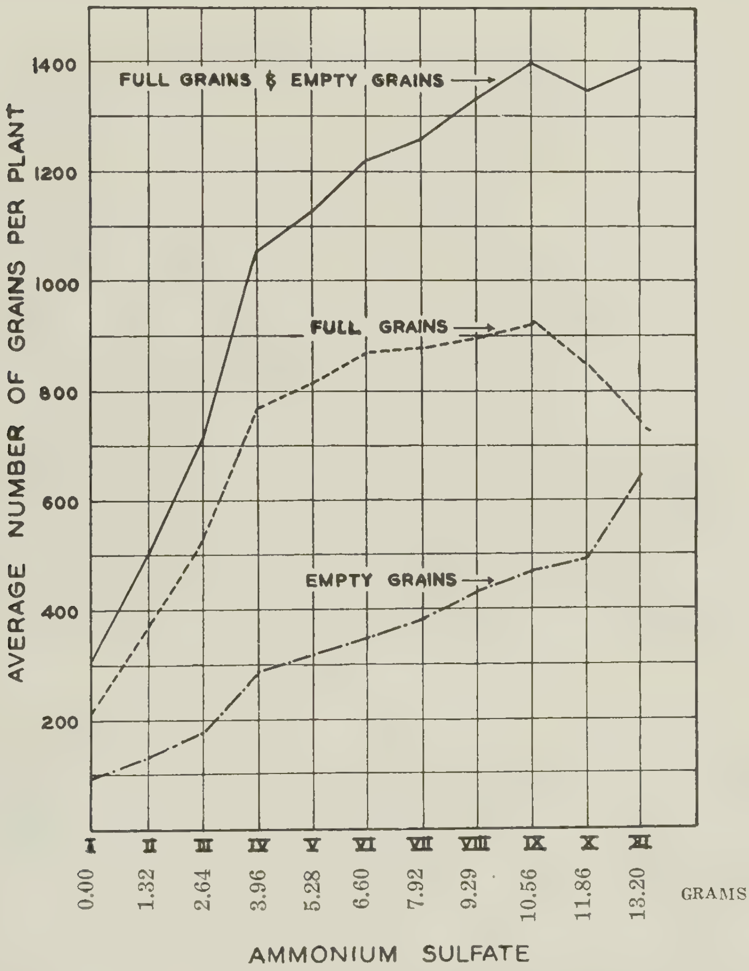


Fig. 1.—Averages per hill of the number of filled grains, unfilled grains, and both, obtained from rice plants grown on clay loam supplied with varying amounts of ammonium sulfate.

creases were noted. In other words, the number of filled grains produced was adversely affected by the amount of ammonium sulfate greater than 10.56 grams per pot. Conversely, the number of

empty grains increased with the amount of the fertilizer employed (fig. 1).

*Comparative color of the leaves*

In general, the color of the leaves in the same culture was very uniform, and there was no marked change in the color during the first two weeks.

The increase in the amount of ammonium sulfate used was accompanied by an increase in the intensity of the green color. This observation confirmed the findings of Libatique (1931) and Soriano (1934). Under the conditions of the experiment, the lightest green was cosse green; and the deepest, spinach green.

The intensity of the green of the leaves was found to decrease as the plants advanced in age, thus confirming the report of Soriano (1934). The change in the color was most rapid in cultures I to VI, and about one week after the beginning of the grain-forming period, hardly any difference in the color could be detected. The rate of change in the color of the leaves in cultures VII to IX was somewhat retarded, but towards the last week of the maturation period, the color was more or less identical in these cultures. The last two cultures which received the highest amounts of ammonium sulfate were apparently very slow in the change of the color, and rarely any change could be observed until about one week before the harvest time. Even at the harvest time, the green of the leaves of the plants in cultures IX and X was still very deep when compared with the color of the leaves of the other cultures.

*Rate of flowering*

The period of flowering began as early as sixty-seven days after planting in cultures II, III, IV, and VII (table 2). No difference could be observed in the duration of the flowering periods of the plants in culture I, which received the smallest amount of ammonium sulfate, and the control. Owing to the earliness in the flowering of the plants in cultures II, III, and IV, culture II completed its flowering period only two days later than the control, while cultures III and IV, which received larger amounts of the fertilizer, completed flowering four days later than the control. The other cultures which were more liberally supplied with ammonium sulfate completed the flowering period much later. The longest period of flowering, twenty-three days, was obtained from culture X, which received the largest amount of ammonium sulfate.

The highest number of inflorescences produced from each culture per two-day interval was forty-nine and was observed in culture VI, which received the fertilizer at the rate of 7.92 grams per pot. With a slight discrepancy, the total number of inflorescences produced from every six similar cultures increased gradually from 94 to 229 as the amount of ammonium sulfate was increased.

### *Rate of maturity of grains*

The mature grains given in table 3 were produced in each culture comprising a total of twelve plants, at three-day intervals. The ripening of the grains, that is, when they turned yellow or straw-color, began as early as eighty-one days after planting or approximately fifteen days after the beginning of the flowering period. It appeared to be related to the earliness or lateness in the flowering of the plants. Cultures II to V produced mature grains about three days earlier than the control. But the greatest number of ripe grains (table 3) appeared simultaneously on the fertilized cultures (I to VII inclusive) on November 6, 1938, or twenty-seven days after flowering. Cultures VIII and IX, which were fertilized even more liberally than any of the preceding seven cultures, produced the maximum ripe grains on November 9, 1938, or three days later. And culture X, which received the greatest amount of the fertilizer tested, produced the largest number of mature grains on November 12, 1938. It thus appeared that the ripening of the rice grains was delayed by a liberal application of ammonium sulfate. As a whole, the ammonium sulfate-fertilized cultures completed the ripening of their grains three days later than the control (table 3).

### *Size of grains*

*Size of unhulled grains.* The differences in the size of the unhulled grain obtained from different cultures show that the fertilized cultures (I to VII) had a general but very slight increase over the control in the length, breadth, and thickness of the unhulled grain (table 4). Among the seven cultures, III, IV, and V had the highest values of the mean thickness, length, and breadth. In general, however, the values of the mean length, breadth, and thickness of the unhulled grains from cultures VIII, IX, and X were smaller than those of the control. These three cultures had a slow rate of flowering and maturity of grains.

*Size of hulled grains.* The size of the hulled grain generally followed closely the variation of the size of the unhulled grain. The

same general statement could be made, as in the case of the unhulled grain, that the length, breadth, and thickness of the hulled grain from the control culture were in all cases less than those from cultures I to VII. The hulled grain of the control was longer and broader than the grains of cultures VIII, IX, and X, thus, to a certain degree, following the trend of the variation in size of the unhulled grains obtained from those cultures. The highest value of the mean length of the hulled grain was found in culture III; and the highest of the mean breadth and thickness, in culture V. These two cultures had a high rate of flowering and maturity of grains. Of the samples used in this study, the size of the hulled grain seemed to be more consistent than the size of the unhulled grain; of the three dimensions studied in the case of the hulled grains, the length was obviously the least variable based on the coefficient of variation, thus confirming the reports of Juliano (1938) and Apaoan (1939).

From the results, it seems that a moderate application of ammonium sulfate to Lipa clay loam in pots was conducive to a slight increase in the size of the rice grain. Conversely, it might also be suspected that a liberal application of the fertilizer tended to produce a slight decrease in the size of the grain as compared with the control.

*Volume of the fifty grain samples*

The mean volumes of the fifty-hulled-grain samples obtained from the eleven cultures are given in table 1. The volume followed very closely the measurement of the size of the grains. A general increase in the volume was observed in cultures I to VIII over the control culture. Although the length and the breadth of the grain from culture VIII were smaller than those of the control, the thickness of the former was greater than that of the control, thus making the mean volume of the sample from culture VIII greater than the mean volume of the control. The largest volume of the sample was obtained in cultures IV and V, which ranked highest in the values of mean thickness and breadth of hulled grains.

## SUMMARY AND CONCLUSIONS

1. The number of filled grains increased with the increase of the amount of ammonium sulfate used up to 10.56 grams per pot; thence gradual decreases were noted with increase of the fertilizer. The number of empty grains increased with the amount of the fertilizer employed.

2. The intensity of the green of the leaves increased with the increase in the amount of ammonium sulfate. At an increasing rate

up to 6.60 grams per pot, the fertilizer did not produce much variation in the color, particularly towards the maturity of the plants. Larger amounts of the fertilizer produced rice plants with darker green leaves.

3. Increases in the amounts of sulfate of ammonia employed tended to delay and to prolong the period of flowering. At the rate of 7.92 grams per pot, the plants produced the largest number of flowers at intervals of two days.

4. A delay in the ripening of grains was observed as the amount of ammonium sulfate was increased above 9.24 grams per pot. The cultures fertilized with ammonium sulfate completed the ripening of their grains three days later than the control.

5. A moderate application of ammonium sulfate was conducive to a slight increase in the size of the grain. A liberal application, however, tended to a slight decrease in the size of the grain as compared with that of the control.

6. The volume gave indication of following very closely the measurement of the size of the grains. The largest volume of the sample was obtained in cultures which ranked highest in the values of mean thickness and breadth of hulled grains.

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TABLE 1

*Numbers of bearing culms, filled and empty grains, and volume of fifty grain samples (all average per hill) of rice plants grown in Lipa clay loam in pots supplied with varying amounts of ammonium sulfate*

| CULTURE NO. | AMOUNT OF AMMONIUM SULFATE USED | NUMBER OF BEARING CULMS PER HILL | NUMBER OF FILLED GRAINS | NUMBER OF EMPTY GRAINS | VOLUME OF FIFTY HULLED GRAIN SAMPLE |
|---|---|---|---|---|---|
| | *grams* | | | | *ml.* |
| I | 1.32 | 7.83 | 366.3 | 128.1 | 0.7792 ± 0.0054 |
| II | 2.64 | 8.17 | 525.9 | 178.4 | 0.7812 ± 0.0041 |
| III | 3.96 | 10.67 | 769.2 | 282.8 | 0.7792 ± 0.0050 |
| IV | 5.28 | 13.00 | 805.3 | 311.0 | 0.7875 ± 0.0067 |
| V | 6.60 | 13.25 | 867.1 | 342.3 | 0.7875 ± 0.0061 |
| VI | 7.92 | 13.67 | 869.6 | 381.3 | 0.7667 ± 0.0059 |
| VII | 9.24 | 15.42 | 888.5 | 427.2 | 0.7687 ± 0.0042 |
| VIII | 10.56 | 14.33 | 911.5 | 473.0 | 0.7625 ± 0.0082 |
| IX | 11.88 | 14.33 | 848.9 | 495.8 | 0.7250 ± 0.0090 |
| X | 13.20 | 19.08 | 748.9 | 642.8 | 0.7121 ± 0.0084 |
| XI | Control | 5.00 | 215.8 | 88.7 | 0.7604 ± 0.0032 |

TABLE 2

*Rate of flowering of rice plants grown in Lipa clay loam in pots supplied with varying amounts of ammonium sulfate*

| CULTURE NO. | AMOUNT OF AMMONIUM SULFATE USED | MAXIMUM PERIOD OF FLOWERING | NUMBER OF INFLORESCENCES PRODUCED AT TWO-DAY INTERVALS[a] | | | | | | | | | | | | | TOTAL NUMBER OF INFLORESCENCES PRODUCED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | October, 1938 | | | | | | | | | | | Nov., 1938 | | |
| | | | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 2 | 4 | |
| | *grams* | *days* | | | | | | | | | | | | | | |
| I | 1.32 | 11 | | 14 | 21 | *27* | 20 | 11 | 1 | | | | | | | 94 |
| II | 2.64 | 15 | 3 | 7 | 16 | 24 | *25* | 17 | 4 | 2 | | | | | | 98 |
| III | 3.96 | 17 | 2 | 9 | 14 | 30 | *38* | 19 | 9 | 3 | 4 | | | | | 128 |
| IV | 5.28 | 17 | 4 | 11 | 27 | *42* | 35 | 26 | 9 | 5 | 1 | | | | | 160 |
| V | 6.60 | 15 | | 3 | 15 | 22 | 41 | *45* | 23 | 9 | 1 | | | | | 159 |
| VI | 7.92 | 15 | | 3 | 16 | 32 | *49* | 37 | 14 | 10 | 3 | | | | | 164 |
| VII | 9.24 | 21 | 1 | 8 | 19 | 33 | *41* | 33 | 16 | 16 | 8 | 4 | 6 | | | 185 |
| VIII | 10.56 | 19 | | 5 | 15 | 26 | 28 | *40* | 22 | 19 | 10 | 4 | 3 | | | 172 |
| IX | 11.88 | 21 | | | 7 | 14 | 12 | *26* | *26* | 15 | 17 | 14 | 19 | 15 | 7 | 172 |
| X | 13.20 | 23 | | 1 | 1 | 8 | 30 | *36* | 25 | 23 | 27 | 12 | 17 | 10 | 19 | 209 |
| XI | Control | 11 | | 1 | 4 | 20 | *22* | 12 | 1 | | | | | | | 60 |

[a] The highest value in each culture is italicized

TABLE 3

*Rate of maturity of grains of rice plants grown in Lipa clay loam in pots supplied with varying amounts of ammonium sulfate*

| CULTURE NO. | AMOUNT OF AMMONIUM SULFATE USED | PERIOD OF FLOWERING[a] | NUMBER OF INFLORESCENCES[a] PRODUCED | NUMBER OF MATURE GRAINS PRODUCED AT 3-DAY INTERVAL | | | | | | | | TOTAL NUMBER OF FILLED GRAINS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | October, 1938 | | | November, 1938 | | | | | |
| | | | | 25 | 28 | 31 | 3 | 6 | 9 | 12 | 15 | |
| | *grams* | *days* | | | | | | | | | | |
| I | 1.32 | 11 | 94 | — | 195 | 613 | 1144 | *1499* | 661 | 256 | 28 | 4396 |
| II | 2.64 | 15 | 98 | 32 | 236 | 550 | 1624 | *2192* | 1023 | 595 | 59 | 6311 |
| III | 3.96 | 17 | 128 | 47 | 202 | 977 | 2787 | *2995* | 1675 | 533 | 18 | 9234 |
| IV | 5.28 | 17 | 160 | 60 | 256 | 947 | 2929 | *3511* | 1547 | 398 | 15 | 9663 |
| V | 6.60 | 15 | 159 | 12 | 31 | 371 | 2783 | *4025* | 2654 | 479 | — | 10355 |
| VI | 7.92 | 15 | 164 | — | — | 334 | 3113 | *4426* | 2064 | 498 | — | 10435 |
| VII | 9.24 | 21 | 185 | — | 89 | 704 | 2220 | *3153* | 2558 | 1447 | 491 | 10662 |
| VIII | 10.56 | 19 | 172 | — | 158 | 683 | 1767 | 2747 | *2749* | 2125 | 709 | 10938 |
| IX | 11.88 | 21 | 172 | — | 21 | 186 | 903 | 2038 | *2754* | 2599 | 1686 | 10187 |
| X | 13.20 | 23 | 209 | — | 12 | 50 | 431 | 1622 | 2467 | *2751* | 1654 | 8987 |
| XI | Control | 11 | 60 | — | 6 | 84 | 397 | *1057* | 773 | 340 | — | 2657 |

[a] Taken from table 6

[b] The highest value in each culture is italicized

TABLE 4

*Mean length, breadth, and thickness, in millimeters of unhulled grains*

| CULTURE NO. | AMOUNT OF AMMONIUM SULFATE USED | LENGTH | | |
|---|---|---|---|---|
| | | MEAN | STANDARD DEVIATION | COEFFICIENT OF VARIATION |
| | *grams* | | | *per cent* |
| I | 1.32 | 7.7954 ± 0.0085 | 0.3074 ± 0.0060 | 3.9461 ± 0.0573 |
| II | 2.64 | 7.7900 ± 0.0101 | 0.3651 ± 0.0071 | 4.7005 ± 0.0915 |
| III | 3.96 | 7.7810 ± 0.0101 | 0.3688 ± 0.0072 | 4.7411 ± 0.0923 |
| IV | 5.28 | 7.7993 ± 0.0109 | 0.3983 ± 0.0077 | 5.1064 ± 0.0994 |
| V | 6.60 | 7.7440 ± 0.0097 | 0.3547 ± 0.0069 | 4.6366 ± 0.0903 |
| VI | 7.92 | 7.7570 ± 0.0102 | 0.3723 ± 0.0072 | 4.8004 ± 0.0934 |
| VII | 9.24 | 7.7030 ± 0.0099 | 0.3628 ± 0.0071 | 4.7127 ± 0.0917 |
| VIII | 10.56 | 7.6616 ± 0.0113 | 0.4101 ± 0.0079 | 5.3545 ± 0.1041 |
| IX | 11.88 | 7.6507 ± 0.0109 | 0.3963 ± 0.0077 | 5.0496 ± 0.0983 |
| X | 13.20 | 7.4430 ± 0.0101 | 0.3682 ± 0.0072 | 4.9489 ± 0.0954 |
| XI | Control | 7.6843 ± 0.0095 | 0.3456 ± 0.0067 | 4.5000 ± 0.0876 |
| | | THICKNESS | | |
| I | 1.32 | 2.1943 ± 0.0024 | 0.0868 ± 0.0017 | 3.9635 ± 0.0772 |
| II | 2.64 | 2.2050 ± 0.0023 | 0.0836 ± 0.0016 | 3.8000 ± 0.0740 |
| III | 3.96 | 2.2263 ± 0.0024 | 0.0859 ± 0.0017 | 3.8475 ± 0.0749 |
| IV | 5.28 | 2.2146 ± 0.0026 | 0.0956 ± 0.0018 | 4.3303 ± 0.0843 |
| V | 6.60 | 2.2144 ± 0.0018 | 0.0660 ± 0.0013 | 2.9909 ± 0.0582 |
| VI | 7.92 | 2.2089 ± 0.0027 | 0.0977 ± 0.0019 | 4.4230 ± 0.0862 |
| VII | 9.24 | 2.2114 ± 0.0028 | 0.1011 ± 0.0020 | 4.5670 ± 0.0789 |
| VIII | 10.56 | 2.1868 ± 0.0026 | 0.0959 ± 0.0019 | 4.3991 ± 0.0844 |
| IX | 11.88 | 2.1722 ± 0.0023 | 0.0832 ± 0.0016 | 3.8341 ± 0.0746 |
| X | 13.20 | 2.1758 ± 0.0026 | 0.0973 ± 0.0019 | 4.4838 ± 0.0872 |
| XI | Control | 2.2000 ± 0.0027 | 0.1007 ± 0.0010 | 4.5774 ± 0.0889 |
| | | BREADTH | | |
| I | 1.32 | 3.3177 ± 0.0032 | 0.1146 ± 0.0022 | 3.4622 ± 0.0674 |
| II | 2.64 | 3.3292 ± 0.0032 | 0.1166 ± 0.0023 | 3.5015 ± 0.0682 |
| III | 3.96 | 3.3123 ± 0.0028 | 0.1235 ± 0.0024 | 3.7341 ± 0.0668 |
| IV | 5.28 | 3.3143 ± 0.0034 | 0.1252 ± 0.0030 | 3.7855 ± 0.0737 |
| V | 6.60 | 3.3427 ± 0.0026 | 0.0936 ± 0.0018 | 2.8024 ± 0.0545 |
| VI | 7.92 | 3.2805 ± 0.0035 | 0.1273 ± 0.0025 | 3.8743 ± 0.0753 |
| VII | 9.24 | 3.2817 ± 0.0038 | 0.1387 ± 0.0027 | 4.2264 ± 0.0823 |
| VIII | 10.56 | 3.2536 ± 0.0031 | 0.1243 ± 0.0024 | 3.8246 ± 0.0744 |
| IX | 11.88 | 3.2093 ± 0.0029 | 0.1054 ± 0.0020 | 3.2866 ± 0.0639 |
| X | 13.20 | 3.2402 ± 0.0039 | 0.1398 ± 0.0027 | 4.3148 ± 0.0839 |
| XI | Control | 3.2590 ± 0.0033 | 0.1301 ± 0.0025 | 3.9908 ± 0.0776 |

TABLE 5

*Mean length, breadth, and thickness in millimeters of hulled grains*

| CULTURE NO. | AMOUNT OF AMMONIUM SULFATE USED | MEAN | STANDARD DEVIATION | COEFFICIENT OF VARIATION |
|---|---|---|---|---|
| | | LENGTH | | |
| | *grams* | | | *per cent* |
| I | 1.32 | 5.6028 ± 0.0069 | 0.2504 ± 0.0049 | 4.4732 ± 0.0870 |
| II | 2.64 | 5.5957 ± 0.0069 | 0.2523 ± 0.0049 | 4.3108 ± 0.0839 |
| III | 3.96 | 5.6287 ± 0.0069 | 0.2504 ± 0.0049 | 4.4494 ± 0.0866 |
| IV | 5.28 | 5.6130 ± 0.0069 | 0.2526 ± 0.0049 | 4.5026 ± 0.0876 |
| V | 6.60 | 5.5904 ± 0.0067 | 0.2435 ± 0.0047 | 4.3561 ± 0.0848 |
| VI | 7.92 | 5.5777 ± 0.0065 | 0.2371 ± 0.0046 | 4.2508 ± 0.0827 |
| VII | 9.24 | 5.5674 ± 0.0071 | 0.2593 ± 0.0050 | 4.6592 ± 0.0907 |
| VIII | 10.56 | 5.5586 ± 0.0071 | 0.2586 ± 0.0050 | 4.5611 ± 0.0895 |
| IX | 11.88 | 5.5294 ± 0.0067 | 0.2440 ± 0.0047 | 4.4322 ± 0.0863 |
| X | 13.20 | 5.3644 ± 0.0070 | 0.2540 ± 0.0049 | 4.7388 ± 0.0923 |
| XI | Control | 5.5670 ± 0.0069 | 0.2529 ± 0.0049 | 4.5503 ± 0.0886 |
| | | BREADTH | | |
| I | 1.32 | 1.9364 ± 0.0033 | 0.0927 ± 0.0018 | 4.7835 ± 0.0931 |
| II | 2.64 | 1.9427 ± 0.0022 | 0.0795 ± 0.0015 | 4.0979 ± 0.0798 |
| III | 3.96 | 1.9653 ± 0.0022 | 0.0807 ± 0.0016 | 4.1173 ± 0.0802 |
| IV | 5.28 | 1.9628 ± 0.0025 | 0.0919 ± 0.0017 | 4.6949 ± 0.0914 |
| V | 6.60 | 1.9763 ± 0.0025 | 0.0928 ± 0.0018 | 4.7107 ± 0.0917 |
| VI | 7.92 | 1.9618 ± 0.0026 | 0.0956 ± 0.0019 | 4.8781 ± 0.0950 |
| VII | 9.24 | 1.9525 ± 0.0026 | 0.0954 ± 0.0018 | 4.9884 ± 0.0971 |
| VIII | 10.56 | 1.9375 ± 0.0025 | 0.0910 ± 0.0018 | 4.6907 ± 0.0913 |
| IX | 11.88 | 1.9285 ± 0.0026 | 0.0956 ± 0.0018 | 4.9534 ± 0.0964 |
| X | 13.20 | 1.9347 ± 0.0027 | 0.0984 ± 0.0019 | 5.0984 ± 0.0993 |
| XI | Control | 1.9276 ± 0.0027 | 0.1002 ± 0.0019 | 5.2187 ± 0.1016 |
| | | THICKNESS | | |
| I | 1.32 | 2.7478 ± 0.0024 | 0.0881 ± 0.0017 | 3.2072 ± 0.0624 |
| II | 2.64 | 2.7838 ± 0.0025 | 0.0963 ± 0.0018 | 3.4640 ± 0.0674 |
| III | 3.96 | 2.7967 ± 0.0027 | 0.0991 ± 0.0019 | 3.5555 ± 0.0692 |
| IV | 5.28 | 2.8003 ± 0.0029 | 0.1065 ± 0.0020 | 3.8035 ± 0.0740 |
| V | 6.60 | 2.8147 ± 0.0031 | 0.1127 ± 0.0022 | 4.0106 ± 0.0781 |
| VI | 7.92 | 2.7823 ± 0.0027 | 0.0998 ± 0.0019 | 3.5865 ± 0.0701 |
| VII | 9.24 | 2.7715 ± 0.0029 | 0.1086 ± 0.0021 | 3.9128 ± 0.0760 |
| VIII | 10.56 | 2.7425 ± 0.0029 | 0.1065 ± 0.0021 | 3.8868 ± 0.0757 |
| IX | 11.88 | 2.6891 ± 0.0036 | 0.1316 ± 0.0025 | 4.8959 ± 0.0953 |
| X | 13.20 | 2.7124 ± 0.0031 | 0.1130 ± 0.0022 | 4.1697 ± 0.0811 |
| XI | Control | 2.7472 ± 0.0026 | 0.0970 ± 0.0019 | 3.5237 ± 0.0686 |

# YIELD OF PARA RUBBER SEEDLING TREES IN THE AMERICAN RUBBER PLANTATION COMPANY AT LATUAN, ISABELA, BASILAN ISLAND, ZAMBOANGA[1]

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WITH FOUR TEXT FIGURES

The possibilities of extensive rubber culture in certain districts in Mindanao have attracted the attention of some local capitalists. A number of them actually visited Mindanao to determine for one thing the suitability of some places for rubber growing.

In this paper, data which may prove of some use to prospective investors in the natural rubber industry in this country are presented and analyzed. The records are of a single commercial rubber estate, the American Rubber Plantation Company at Latuan, Isabela, Basilan Island, Zamboanga. Nevertheless, the data possess the merit of being based on ten-year yield records of a typical Philippine commercial rubber estate.

*Object of the present work*

The main purpose of the present work is to analyze the actual yield records in 1925-1930 of 179,000 rubber seedling trees; and in 1934-1937, of 200,000 trees grown at the rubber estate of the American Rubber Plantation Company at Latuan, Isabela, Basilan Island, Zamboanga.

*Time and place of the study*

This study was conducted on the occasion of a trip made, on May 12, 1938, to Basilan Island, Zamboanga. At the rubber estate of the American Rubber Plantation Company at Latuan, Isabela, Basilan Island, Zamboanga, field observations were made and interviews were had with Dr. James W. Strong, manager, and with other officials of the company. Doctor Strong, in addition to furnishing the necessary information, offered to the writer the services of some of the office personnel and farm hands of the company in the course of this study.

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[1] Experiment Station contribution No. 1420.
[2] The author gratefully acknowledges valuable suggestions, data on yield and climate which are reported in this paper, and other valuable assistance received from Dr. James W. Strong, Manager of the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga.

MATERIALS AND METHODS

The actual yield records of 179,000 seedling trees tapped from 1925 to 1930 and of the same trees increased to the tappable number of 200,000 in 1934 to 1937 were obtained.

The seeds from which these trees were grown were imported from Singapore. The seedlings were planted in 1918 and the first commercial tapping was made in 1925.

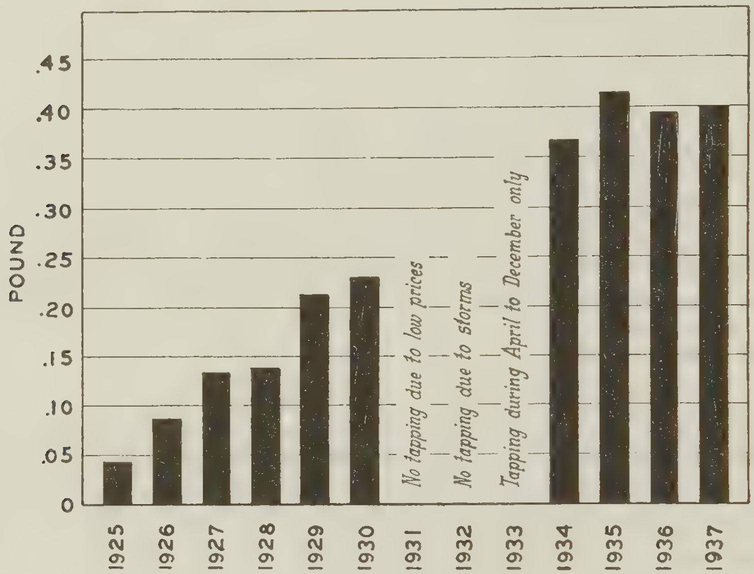


Fig. 1.—Monthly average yield per seedling tree in the American Rubber Plantation Company.

*Rate of planting.* The seedlings were planted at a distance of 6 by 6 meters, or at the rate of 277 trees to the hectare.

### *Tapping*

*Time of first tapping.* All trees which in 1925 attained a trunk diameter of about 15 centimeters (six inches) at a height of 91 centimeters (three feet) from the ground were tapped for the first time. The others were subjected to initial tapping as soon as they had grown to what was set as the tappable stage.

*Tapping equipment.* In the American Rubber Plantation Company, the tapping equipment consists of a spout (6 cm. long, G.I.),

a cup-holder (3 mm. galvanized wire), a cup (coconut shell), a tapping knife (devised by Doctor Strong), a latex pail, and a scrap and bark basket (rattan).

*Tapping operations.* One straight cut slanting downwards from left to right at an angle of 30 degrees is made on one-half of the circumference of the tree. This cut ends in a perpendicular groove cut out following the direction of the trunk. The lower end of the first tapping cut is about 18 inches from the ground. A G.I. spout 6 cm. long, is forced into the bark of the tree just beneath the shallow vertical groove. The latex is caught in this spout and deliv-

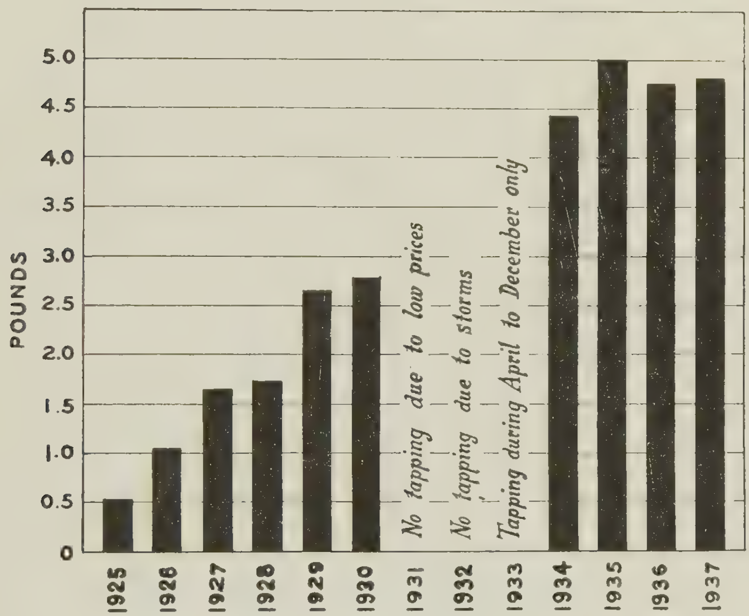


Fig. 2.—Total annual yield per seedling tree in the American Rubber Plantation Company.

ered into a cup made of coconut shell. The latter is held in position by a piece of wire. Before the tree is tapped anew, all the coagulated rubber scrap in the old cut is picked off and the passage of the latex is cleaned down to the spout. Then a new cut is made. The bark parings are saved and collected in rattan baskets. The tapping is done when the trees are relatively dry.

At about 9:00 o'clock in the morning, the latex is collected and poured into a pail, or bucket, carried by the tapper, and brought to

the collecting stations where it is carefully strained. From these stations, the latex is transported to the central factory for processing into smoked sheets and crepe grades No. 2 and No. 3.

All the scraps of rubber coagulated in the cuts, and in the tapping cups the latex that falls to the ground, and the bark parings are utilized in the preparation of lower grades of rubber.

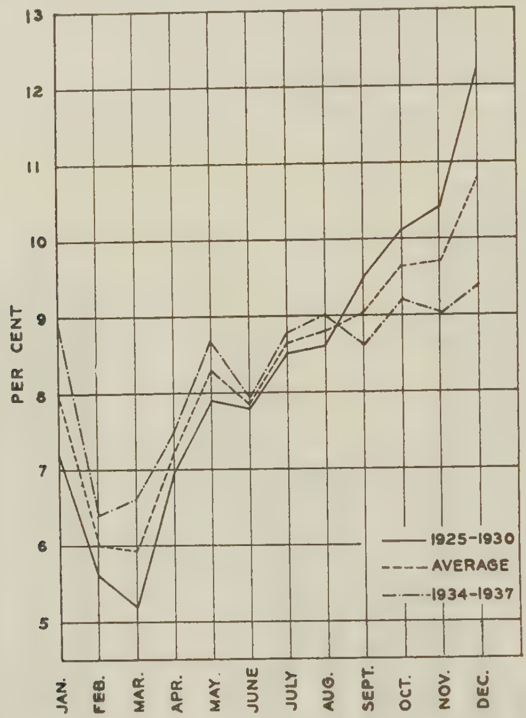


Fig. 3.—Monthly percentage production of rubber in the American Rubber Plantation Company for 1925 to 1930 and 1934 to 1937, based on the total annual yield.

## *Processing*

*Coagulation.* The thoroughly sieved latex is first bulked in large tanks. Clean water is added to reduce the rubber content to two pounds of dry matter per gallon of latex. Then the diluted latex is placed in coagulating tanks. To the diluted latex, a weak solution of acetic acid or formic acid is added and thoroughly mixed. Then aluminum partitions are placed into the tanks and the latex is left to coagulate into soft spongy slabs about five centimeters (two inches) thick.

*Milling.* The slabs are passed through several sets of iron rollers until they are reduced in thickness to five millimeters or one-eight of an inch.

*Smoking.* The pressed sheets are brought to the smoke house where they are dried and cured for a period of ten days. The temperature at the smoke house is maintained at about 130 degrees Fahrenheit. The resulting product is called smoked sheets No. 1.

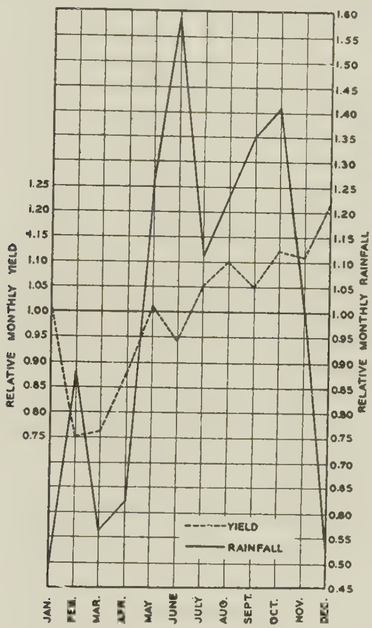


Fig. 4.—Monthly variations in rubber yield and rainfall in terms of the general monthly average for ten years, 1925-1930 and 1934-1937 at the American Rubber Plantation Company, Basilan, Zamboanga.

*Products.* In addition to the smoked sheets No. 1, crepe grades No. 2, and No. 3 are also prepared in much the same manner as the smoked sheets, except that the latter products are dried and cured in an air-drying house instead of in a smoke house. The separate weights of these products are taken and recorded.

## RESULTS AND DISCUSSIONS

*Age of Para rubber and the yield.* The annual and monthly yield of smoked sheets No. 1 and crepe grades No. 2 and No. 3, from 1925 to 1930 and from 1934 to 1937, are given in table 1.

Tapping had been done until 1933 on 179,000 trees since 1925, seven years after planting, and had been continued yearly thereafter except in 1931 and 1932 when tapping had to be abandoned on account of the very low price of rubber and the extremely unfavorable weather conditions; and on 200,000 trees from 1934 to 1937.

Table 1, as well as table 2 and figure 2, shows that the yields of rubber generally increase progressively with the age of the tree; the collective and individual yield in 1937 when the trees were nineteen years was almost ten times as that in 1925 when the trees were only 7 years old.

The increase in yield may be attributed to the increase in size of girth and thickness of the bark tissues.

*Monthly variations in the yield.* The percentages of monthly distribution in yield based on the total annual output, for the period covered by this study, are presented in table 3 and illustrated in figure 3. Although the trees were tapped regularly throughout the year, marked difference in yield occurred from month to month. The major portion of the crop, 57.17 per cent, was obtained during a period of six months, from July to December. The crop during the months of February, March, and April—a period of three months—was very low. It is during these months that the trees had parts of their foliage shed off.

*Rainfall and yield.* The monthly averages of yield of rubber were changed into relatives based on the general monthly average which is evaluated as unity. The data are set in table 4 and charted in figure 4 against the monthly averages of rainfall also changed into relatives. In general, the low yields during the months of February, March, and April were associated with relatively low rainfall, and heavy yields from May to November, with relatively higher rainfall. This relationship is not, however, consistent. A closer analysis of table 4 and figure 4 indicates that the monthly yield changes without apparent regard to the average total rainfall. This observation is confirmed by the absence of a positive correlation coefficient, which is $0.2479 \pm 0.1827$, between rainfall and monthly yield for a period of ten years. The rains which are most likely to affect the monthly yield of rubber are those that fall during the mornings for they interfere with the tapping work in the field.

## SUMMARY

1. The total annual yield of dry rubber per seedling tree at the American Rubber Plantation Company at Latuan, Isabela, Ba-

silan Island, Zamboanga, was 0.532 pound, or 241.31 grams, from 7-year old; and 4.806 pounds, or 2.18 kilograms, from 19-year old trees.

2. The yield increased generally and progressively with age.

3. Marked variations in the monthly yield were observed.

4. The major portion of the crop was obtained from July to December, 57.17 per cent on the average, for ten years.

5. The yield was lowest in the months of February, March, and April.

6. There is no positive correlation between rainfall and yield. It must be understood in this connection that rains which are most likely to affect the monthly yield in rubber are those falling during the morning for they interfere with the tapping work.

TABLE 1

*Total annual monthly output of dry rubber in the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga*

| YEAR | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | TOTAL | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* |
| 1925 | 5763 | 4709 | 5108 | 4899 | 7595 | 7755 | 7638 | 4000 | 9085 | 11479 | 13211 | 14995 | 96737 | 8061.4 |
| 1926 | 10371 | 10012 | 10500 | 12369 | 14283 | 13939 | 17312 | 16973 | 17669 | 18245 | 23994 | 25013 | 190680 | 15890.0 |
| 1927 | 27245 | 18243 | 12725 | 19568 | 17558 | 18710 | 26944 | 33723 | 33413 | 30174 | 25949 | 34117 | 298369 | 24864.0 |
| 1928 | 24448 | 19251 | 13190 | 23497 | 25616 | 25995 | 24798 | 25318 | 30631 | 27298 | 31705 | 35987 | 307734 | 25644.5 |
| 1929 | 32751 | 20554 | 24988 | 30053 | 44071 | 40255 | 41503 | 50010 | 40916 | 46754 | 38980 | 53278 | 464113 | 38676.1 |
| 1930 | 39397 | 33989 | 35441 | 44312 | 41319 | 38530 | 40001 | 49588 | 40412 | 48564 | 43077 | 49627 | 504257 | 42021.4 |
| 1931 | | | | | No tapping due to sudden fall of prices | | | | | | | | | |
| 1932 | | | | | No tapping due to storm | | | | | | | | | |
| 1933 | | | | | Tapping was done only from April-December | | | | | | | | | |
| 1934 | 75717 | 46082 | 53998 | 61493 | 81319 | 65563 | 77961 | 79421 | 78010 | 89380 | 89287 | 91603 | 889834 | 74152.8 |
| 1935 | 96428 | 75813 | 71378 | 80499 | 85023 | 79153 | 85798 | 91093 | 78894 | 90833 | 82654 | 87868 | 1005434 | 83786.1 |
| 1936 | 83919 | 59108 | 63145 | 69634 | 78302 | 81541 | 88281 | 86100 | 85952 | 86815 | 85208 | 88771 | 956776 | 79731.3 |
| 1937 | 85075 | 67997 | 66379 | 71094 | 82472 | 73904 | 86606 | 85225 | 83096 | 82021 | 88620 | 90932 | 963421 | 80285.1 |
| Total | 481614 | 355758 | 356852 | 417418 | 477558 | 445345 | 496842 | 521451 | 498078 | 531563 | 522685 | 572191 | 5677355 | 473112.7 |
| Average | 48161.4 | 35575.8 | 35685.2 | 41741.8 | 47755.8 | 44534.5 | 49684.2 | 52145.1 | 49807.8 | 53156.3 | 52268.5 | 57219.1 | 567735.5 | 47311.27 |

TABLE 2

*Calculated monthly and annual yields per seedling tree for ten years of actual tapping in the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga*

| MONTHS | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1934 | 1935 | 1936 | 1937 | TOTAL | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* | *lbs.* |
| January | 0.032 | 0.057 | 0.152 | 0.136 | 0.182 | 0.220 | 0.378 | 0.482 | 0.419 | 0.425 | 2.483 | 0.2483 |
| February | 0.026 | 0.055 | 0.101 | 0.107 | 0.114 | 0.189 | 0.230 | 0.379 | 0.295 | 0.339 | 1.835 | 0.1835 |
| March | 0.028 | 0.058 | 0.071 | 0.073 | 0.139 | 0.192 | 0.269 | 0.356 | 0.315 | 0.331 | 1.832 | 0.1832 |
| April | 0.027 | 0.069 | 0.109 | 0.131 | 0.167 | 0.247 | 0.307 | 0.402 | 0.348 | 0.355 | 2.162 | 0.2162 |
| May | 0.042 | 0.079 | 0.098 | 0.143 | 0.246 | 0.230 | 0.406 | 0.425 | 0.391 | 0.412 | 2.472 | 0.2472 |
| June | 0.043 | 0.077 | 0.104 | 0.145 | 0.224 | 0.215 | 0.327 | 0.395 | 0.407 | 0.369 | 2.306 | 0.2306 |
| July | 0.042 | 0.096 | 0.150 | 0.138 | 0.231 | 0.223 | 0.389 | 0.428 | 0.441 | 0.433 | 2.571 | 0.2571 |
| August | 0.022 | 0.094 | 0.188 | 0.141 | 0.279 | 0.227 | 0.397 | 0.455 | 0.430 | 0.426 | 2.709 | 0.2709 |
| September | 0.050 | 0.098 | 0.186 | 0.171 | 0.228 | 0.225 | 0.390 | 0.394 | 0.429 | 0.415 | 2.586 | 0.2586 |
| October | 0.064 | 0.101 | 0.168 | 0.152 | 0.261 | 0.271 | 0.446 | 0.454 | 0.434 | 0.405 | 2.756 | 0.2756 |
| November | 0.073 | 0.134 | 0.144 | 0.177 | 0.217 | 0.240 | 0.446 | 0.413 | 0.426 | 0.443 | 2.713 | 0.2713 |
| December | 0.083 | 0.139 | 0.190 | 0.201 | 0.297 | 0.277 | 0.458 | 0.439 | 0.443 | 0.454 | 2.981 | 0.2981 |
| Total | 0.532 | 1.057 | 1.661 | 1.715 | 2.585 | 2.806 | 4.443 | 5.022 | 4.778 | 4.807 | 29.406 | 2.9406 |
| Average | 0.044 | 0.088 | 0.138 | 0.142 | 0.215 | 0.233 | 0.370 | 0.418 | 0.398 | 0.400 | 2.446 | 0.2446 |

TABLE 3

*Percentage of monthly yield of Para rubber seedling trees in the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga from 1925 to 1930 and 1934 to 1937, based on the total annual yield*

| MONTHS | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | AVERAGE FOR 1925 TO 1930 | 1934 | 1935 | 1936 | 1937 | AVERAGE FOR 1934 TO 1937 | AVERAGE FOR TEN YEARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* | *per cent* |
| Jan. | 6.0 | 5.3 | 9.1 | 7.9 | 7.1 | 8.0 | 7.2 | 8.5 | 9.6 | 8.7 | 8.7 | 8.9 | 7.89 |
| Feb. | 4.8 | 5.2 | 6.1 | 6.3 | 4.4 | 6.9 | 5.6 | 5.2 | 7.5 | 6.2 | 6.9 | 6.4 | 5.95 |
| Mar. | 5.7 | 5.4 | 4.3 | 4.3 | 5.4 | 7.0 | 5.3 | 6.0 | 7.1 | 6.6 | 6.7 | 6.6 | 5.85 |
| Apr. | 5.1 | 6.5 | 6.6 | 7.6 | 6.5 | 8.9 | 6.9 | 6.9 | 8.0 | 7.3 | 7.9 | 7.5 | 7.13 |
| May | 7.8 | 7.5 | 5.9 | 8.3 | 9.3 | 8.3 | 7.9 | 9.1 | 8.5 | 8.2 | 8.9 | 8.7 | 8.18 |
| June | 8.1 | 7.3 | 6.3 | 8.5 | 8.7 | 7.8 | 7.8 | 7.4 | 7.9 | 8.5 | 7.8 | 7.9 | 7.83 |
| July | 7.9 | 9.1 | 9.0 | 8.1 | 8.9 | 8.1 | 8.5 | 8.8 | 8.5 | 9.2 | 8.8 | 8.8 | 8.64 |
| Aug. | 4.1 | 8.9 | 11.3 | 8.2 | 10.8 | 8.2 | 8.6 | 8.9 | 9.1 | 9.0 | 8.9 | 9.0 | 8.74 |
| Sept. | 9.4 | 9.3 | 11.2 | 9.9 | 8.8 | 8.2 | 9.5 | 8.9 | 7.8 | 9.0 | 8.7 | 8.6 | 9.12 |
| Oct. | 12.0 | 9.6 | 10.1 | 8.9 | 10.6 | 9.8 | 10.1 | 10.0 | 9.0 | 9.1 | 8.7 | 9.2 | 9.78 |
| Nov. | 13.6 | 12.7 | 8.7 | 10.3 | 8.4 | 8.7 | 10.4 | 10.0 | 8.2 | 8.9 | 9.0 | 9.0 | 9.85 |
| Dec. | 15.5 | 13.2 | 11.4 | 11.7 | 11.1 | 10.1 | 12.2 | 10.3 | 8.8 | 9.3 | 9.0 | 9.4 | 11.04 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

TABLE 4

*Monthly variations in rubber yield and rainfall in terms of the general monthly average at the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga for ten years, 1925-1930 and 1934-1937*

| MONTHS | AVERAGE OF TOTAL YIELD FOR TEN YEARS | | AVERAGE OF TOTAL RAINFALL FOR TEN YEARS | |
|---|---|---|---|---|
| | Average yield for each month | Relative monthly yield | Average rainfall for each month | Relative monthly rainfall |
| | *pounds* | | *inches* | |
| January | 48,161.4 | 1.02 | 27.68 | 0.48 |
| February | 35,575.8 | 0.75 | 50.52 | 0.88 |
| March | 35,685.2 | 0.76 | 32.39 | 0.56 |
| April | 41,741.8 | 0.88 | 35.59 | 0.62 |
| May | 47,755.8 | 1.01 | 71.78 | 1.25 |
| June | 44,534.5 | 0.94 | 91.60 | 1.59 |
| July | 49,684.2 | 1.05 | 63.89 | 1.11 |
| August | 52,145.1 | 1.10 | 70.91 | 1.23 |
| September | 49,807.8 | 1.05 | 77.37 | 1.35 |
| October | 53,156.3 | 1.12 | 80.85 | 1.41 |
| November | 52,268.5 | 1.11 | 57.79 | 1.01 |
| December | 57,219.1 | 1.21 | 29.50 | 0.51 |
| Total | 567,735.5 | —— | 689.87 | —— |
| General monthly average | 47,311.3 | 1.00 | 57.48 | 1.00 |

TABLE 5

*Average total monthly and annual rainfall in the American Rubber Plantation Company, Latuan, Isabela, Basilan Island, Zamboanga*

| YEAR | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | TOTAL | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* | *inches* |
| 1925 | 2.68 | 5.51 | 4.52 | 2.74 | 4.81 | 6.67 | 8.74 | 7.25 | 8.09 | 7.22 | 4.44 | 2.35 | 65.02 | 5.42 |
| 1926 | 8.02 | — | — | 1.48 | 1.81 | 7.83 | 9.22 | 7.53 | 12.75 | 8.77 | 11.04 | 4.18 | 72.63 | 6.05 |
| 1927 | 0.87 | 1.07 | 2.88 | 2.40 | 6.56 | 6.28 | 3.65 | 4.02 | 9.58 | 10.49 | 10.87 | 4.01 | 62.68 | 5.22 |
| 1928 | 2.03 | 19.06 | 0.82 | 9.09 | 6.00 | 8.44 | 8.36 | 11.17 | 4.25 | 16.17 | 5.07 | 4.17 | 94.63 | 7.89 |
| 1929 | 1.77 | 1.18 | 5.75 | 2.56 | 5.53 | 9.16 | 4.87 | 4.29 | 8.62 | 9.29 | 5.36 | 1.50 | 59.88 | 4.99 |
| 1930 | 1.76 | — | 0.55 | 3.35 | 5.54 | 17.89 | 2.97 | 7.58 | 5.01 | 3.52 | 5.95 | 3.05 | 57.17 | 4.76 |
| 1931 | | | | | No tapping due to sudden fall of prices | | | | | | | | | |
| 1932 | | | | | No tapping due to storm | | | | | | | | | |
| 1933 | | | | | Tapping was done only from April to December | | | | | | | | | |
| 1934 | 5.95 | 18.81 | 9.70 | 5.73 | 11.25 | 7.43 | 10.38 | 8.83 | 7.75 | 5.72 | 5.27 | 3.40 | 100.22 | 8.35 |
| 1935 | 0.48 | 2.47 | 2.94 | 1.29 | 10.72 | 8.91 | 7.24 | 5.03 | 6.41 | 4.04 | 3.45 | 2.23 | 55.21 | 4.60 |
| 1936 | 2.18 | 0.38 | 3.23 | 2.97 | 7.47 | 6.16 | 5.90 | 7.94 | 6.40 | 8.01 | 1.62 | 2.52 | 54.78 | 4.57 |
| 1937 | 1.94 | 2.04 | 2.00 | 3.98 | 12.09 | 12.83 | 2.56 | 7.27 | 8.51 | 7.62 | 4.72 | 2.09 | 67.65 | 5.64 |
| Total | 27.68 | 50.52 | 32.39 | 35.59 | 71.78 | 91.60 | 63.89 | 70.91 | 77.37 | 80.85 | 57.79 | 29.50 | 689.87 | 57.49 |
| Average | 2.768 | 5.052 | 3.239 | 3.559 | 7.178 | 9.160 | 6.389 | 7.091 | 7.737 | 8.085 | 5.779 | 2.950 | 68.987 | 5.749 |

# A STUDY ON THE WEEDS INFESTING PASTURES AND THE COST OF REMOVING THEM BY GRUBBING[1]

PEDRO J. ZUÑIGA

One of the most important problems confronting cattle raisers in the Philippines is the maintenance of productive pastures. Undoubtedly, the presence of weeds is a big factor in reducing the capacity of pastures. The removal of these weeds would do much to permit the maintenance of a greater number of animals per unit area of range. Various methods of removing weeds have been advocated. This study was undertaken to find out the practicability of removing weeds by grubbing.

Babaran (1937) found that in Los Baños, the total cost of cutting the weeds in the hillside pastures was, on the average, ₱20.94 per hectare during the year; and in the plain, ₱10.61. Barsana (1927)[2] states that one-fifth of the total pasture land of the College of Agriculture was useless because of weeds.

Sampson (1914) believes that the decline in the productivity of a pasture may be accounted for, by the many weeds, abnormal climatic conditions, improper handling of the stock, or various allied conditions. He suggests that the pasture be grazed to sheep and mowed three times during summer, before the ripening of the seeds. He further advocates that cattle, horses, and sheep be grazed together as mixed grazing affords a clean, even cropping of the entire pasture.

Manresa, Pepito, and Silva (1938) found that the best combination of removing weeds from the pastures was by cutting, burning, and grubbing. Each operation was done at intervals of three months. Of these single treatments, grubbing was the most effective in eradicating weeds; cutting, second; and burning, the least.

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[1] Experiment Station contribution No. 1421. Prepared in the Department of Animal Husbandry under the direction of Associate Professor Valente Villegas.

[2] BARSANA, JOSÉ G. A study of the system of cattle management in Batanes and in the College of Agriculture with the view of introducing possible improvements in Batanes. Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. 1927. (Unpublished)

Tabor (1922) claims that a weedy pasture is an indication of poor management and low soil fertility. He states further that two or three cuttings of weeds would materially reduce their number the following year.

The objects of the present work were: (*a*) to find out the species of undesirable plants infesting the pastures from month to month for a period of one year, (*b*) to determine the extent of infestation as indicated by the weight of the weeds at the time they were grubbed, and (*c*) to ascertain the time and cost of grubbing them up.

The experiment was conducted in the pastures of the Department of Animal Husbandry, College of Agriculture, University of the Philippines from June 30, 1937 to June 8, 1938.

*Pastures.* There were ten lots, five on the hillside and five on the plain, each with an area of one hectare. The boundaries of each were marked with stakes fifty meters apart so as not to interfere with the grazing of animals. The lots on the hillside were designated as hillside pastures, I, II, III, IV, and V, and those on the plain as plain pastures, I, II, III, IV, and V. Care was taken not to allow the animals to overgraze.

*Implements used.* Grub hoes and mattock axes were used for removing the weeds. These were sharpened whenever necessary. A Renfrew scale of 2,000 lbs. (909 kgm.) capacity was used for weighing freshly grubbed weeds.

Spading forks were used for piling the weeds; and ordinary bolos, for cutting the branches of tall weeds before grubbing.

## PROCEDURE

Grubbing up of weeds was done as soon as they began to shade and encroach on the growth and well-being of the grass.

The small weeds were removed with the grub hoe. The mattock axe was used to cut the woody and stout roots of certain weeds after clearing the bases with the grub hoe. The branches of rank plants were cut with the bolo to facilitate grubbing. Then the weeds were removed, collected separately, and weighed while still fresh, according to species.

Two men of average working ability were generally employed to remove the weeds. At times, when the work had to be finished

immediately, more men were employed. The number of hours necessary to grub the weeds in each pasture was recorded, and the cost of weeding each area was determined.

In determining the cost of weeding, the minimum rate of eleven centavos per hour for laborers at the College of Agriculture was used. The number of hours spent for sharpening the tools was added to the time actually spent in removing the weeds to obtain the total cost of weeding.

## DISCUSSION OF RESULTS

### *Species of weeds infesting the pastures*

The weeds infesting the hillside pastures were almost of the same species as those growing on the plain pastures. A great difference existed, however, in the abundance of the individual species as shown in tables 3 and 4, a greater weight having been obtained from the hillside pastures than those from the plain.

The major weeds grubbed up in the hillside pastures during the investigation were: bayabas, *Psidium guajava* Linn.[3]; payang-payang babae, *Flemingia strobilifera* (Linn.) R. Br.; barak *Curcuma zedoaria* (Berg.) Rosc.; palis, *Callicarpa cana* Linn.; lantana, *Lantana camara* Linn.; sambong, *Blumea balsamifera* (Linn.) DC.; payang-payang lalake, *Desmodium pulchellum* (Linn.) Benth.; hagonoy, *Hyptis capitata* Jacq.; suag-cabayo, *Hyptis suaveolens* Poir.; poñgapong, *Amorphophallus campanulatus* (Roxb.) Blm.; dilang-baca, *Elephantopus scaber* Linn.; balatong-aso, *Cassia tora* Linn.; maguilic, *Premna cumingiana* Schauer.; aroma, *Acacia farnesiana* (Linn.) Willd.; sambong-samboñgan, *Blumea lacera* (Burm. f.) DC.; escobang babae, *Sida retusa* Linn.; batino, *Alstonia macrophylla* Wall.; and hicaw-hicawan, *Stachytarpheta jamaicensis* (Linn.) Vahl.

The miscellaneous weeds were uray, *Amaranthus spinosus* Linn.; escobang babae, *Sida retusa* Linn.; bagawak, *Clerodendron quadriloculare* (Blco.) Merr.; asis, *Ficus ulmifolia* Lam.; hauili, *Ficus hauili* Blco.; barak, *Curcuma zedoaria* (Berg.) Rosc.; balatong-aso, *Cassia tora* Linn.; damong-culog, *Vernonia patula* (Dry.) Merr.; lipa, *Laportea meyeniana* (Walp.) Warb.; pandakáki, *Tabernaemontana pandacaqui* Poir.; aroma, *Acacia farnesiana* (Linn.) Willd.; batino, *Alstonia macrophylla* Wall.; dawag, *Capparis horrida* Linn. f.;

[3] MERRILL, E. D. 1923–1926. Enumeration of Philippine flowering plants. Volumes 1-4, vii + 2136 p., 6 pl., 3 fig. Manila: Bureau of Printing.

suag-cabayo, *Hyptis suaveolens* Poir.; tadyang-calabao, *Plectronia monstrosa* A. Rich.; kasupanguil, *Clerodendron intermedium* Cham.; lagundi, *Vitex negundo* Linn.; tagbac, *Kolowratia elegans* Presl.; kalios, *Streblus asper* Lour.; dilang-baca, *Elephantopus scaber* Linn.; maguillic, *Premna cumingiana* Schauer.; bansit, *Phyllanthus reticulatus* Poir.; anonang, *Cordia dichotoma* Forst. f.; lantana, *Lantana camara* Linn.; sambong-samboñgan, *Blumea lacera* (Burm. f.) DC.; escobang babae, *Sida retusa* Linn.; and poñgapong, *Amorphophallus campanulatus* (Roxb.) Blm. It will be seen that some of the major weeds were also considered miscellaneous. This is due to the fact that in the first grubbing, a weed may be considered as major; but in the second grubbing, miscellaneous and vice versa. Also, with individual pastures, a weed may be classified as major in one but miscellaneous in another, so that it may at the same time be considered major and miscellaneous in the summary, as shown in table 1.

In the plain pastures, the following major weeds were found: bayabas, *Psidium guajava* Linn.; sambong, *Blumea balsamifera* (Linn.) DC.; payang-payang babae, *Flemingia strobilifera* (Linn.) R. Br.; payang-payang lalake, *Desmodium pulchellum* (Linn.) Benth.; palis, *Callicarpa cana* Linn.; balatong-aso, *Cassia tora* Linn.; poñgapong, *Amorphophallus campanulatus* (Roxb.) Blm.; suag-cabayo, *Hyptis suaveolens* Poir.; dilang-baca, *Elephantopus scaber* Linn.; escobang babae, *Sida retusa* Linn.; pandakáki, *Tabernaemontana pandacaqui* Poir.; uray, *Amaranthus spinosus* Linn.; maguilic, *Premna cumingiana* Schauer.; barak, *Curcuma zedoaria* (Berg.) Rosc.; and sambong-samboñgan, *Blumea lacera* (Burm. f.) DC.

Under the miscellaneous weeds were the following: lantana, *Lantana camara* Linn.; hagonoy, *Hyptis capitata* Jacq.; luya-luya, *Languas brevilabris* (Presl.) Merr.; maguilic, *Premna cumingiana* Schauer.; hicaw-hicawan, *Stachytarpheta jamaicensis* (Linn.) Vahl; dita, *Alstonia scholaris* (Linn.) R. Br.; suag-cabayo, *Hyptis suaveolens* Poir.; aroma, *Acacia farnesiana* (Linn.) Willd.; batino, *Alstonia macrophylla* Wall.; kulot-kulotan, *Urena lobata* Linn.; escobang babae, *Sida retusa* Linn.; pandakáki, *Tabernaemontana pandacaqui* Poir.; dilang-baca, *Elephantopus scaber* Linn.; balatong-aso, *Cassia tora* Linn.; palis, *Callicarpa cana* Linn.; payang-payang babae; *Flemingia strobilifera* (Linn.) R. Br.; and payang-payang lalake, *Desmodium pulchellum* (Linn.) Benth. Again, for the same reason as before, some of the major weeds were at the same time considered as miscellaneous as shown in table 2.

*Weight of weeds grubbed*

The following weeds occurred during the first grubbing in hillside pasture I in the order of their abundance: payang-payang babae, dilang-baca, palis, sambong, lantana, payang-payang lalake, bayabas, poñgapong, suag-cabayo, sambong-samboñgan, pandakáki, hicaw-hicawan, aroma, and kalios. The miscellaneous weeds include those species which did not yield over twenty-five kilograms of fresh weight. These consisted of uray, escobang babae, bagawak, asis, hauili, barak, and balatong-aso.

During the second grubbing, payang-payang babae and sambong gave high fresh weights, while lantana, balatong-aso, palis, sambong-samboñgan, escobang babae, payang-payang lalake, and bayabas yielded much less. The miscellaneous weeds consisted of hagonoy, suag-cabayo, and dilang-baca.

Several weeds: dilang-baca, poñgapong, suag-cabayo, pandakáki, hicaw-hicawan, aroma, and kalios, which were present during the first grubbing, did not appear during the second, while some, balatong-aso and escobang babae, which were rather scarce during the first grubbing, became abundant afterwards. It seems evident that although some species would not tolerate grubbing, or removal of their stumps, some were able to develop, perhaps from seeds originally present in the ground, after the ground cover was removed.

The major weeds during the first grubbing in plain pasture I, in the descending order of their fresh weights were: sambong, palis, bayabas, poñgapong, payang-payang babae, pandakáki, payang-payang lalake, balatong-aso, maguilic, dilang-baca, uray, suag-cabayo, hicaw-hicawan, barak, sambong-samboñgan, and dita. The miscellaneous weeds included lantana, hagonoy, luya-luya, kalios, damong-culog, and maguilic.

During the second grubbing, only six of the major weeds were able to survive, and these were sambong, sambong-samboñgan, bayabas, palis, balatong-aso, and escobang babae. Escobang babae did not appear in this pasture during the first grubbing but became a major weed during the second. The miscellaneous weeds consisted of payang-payang lalake, payang-payang babae, and lantana.

The weights of the major weeds in their descending order from hillside pasture II were: barak, payang-payang babae, bayabas, sambong, lantana, payang-payang lalake, palis, poñgapong, suag-cabayo, aroma, escobang babae, hicaw-hicawan, dilang-baca, hagonoy, magui-

lic, batino, and pandakáki. The miscellaneous weeds were: balatong-aso, damong-culog, and lipa.

During the second grubbing, eight of the original major weeds grew. These were hagonoy, sambong, bayabas, dilang-baca, payang-payang babae, palis, escobang babae, and sambong-samboñgan.

The major weeds in plain pasture II that were found at the first grubbing were: sambong, balatong-aso, payang-payang lalake, payang-payang babae, palis, poñgapong, escobang babae, dilang-baca, uray, pandakáki, sambong-samboñgan, barak, lantana, and batino. The miscellaneous weeds consisted of suag-cabayo, damong-culog, hicaw-hicawan, and aroma.

Only five major weeds from the first grubbing were found at the second, and these were sambong-samboñgan, sambong, bayabas, poñgapong, and balatong-aso. The miscellaneous weeds included pandakáki, escobang babae, payang-payang lalake, and payang-payang babae.

The major weeds when the first grubbing was made in hillside pasture III were: payang-payang babae, bayabas, suag-cabayo, barak, lantana, balatong-aso, palis, payang-payang lalake, batino, sambong, poñgapong, dilang-baca, maguilic, hagonoy, and escobang babae. The miscellaneous weeds were pandakáki, aroma and dawag. After the first grubbing, no weeds big enough to require second grubbing grew.

There were nine major weeds in plain pasture III during the first grubbing, such as suag-cabayo, bayabas, sambong, escobang babae, payang-payang lalake, payang-payang babae, dilang-baca, barak, and balatong-aso. The miscellaneons weeds were aroma, lantana, and kulot-kulotan. After the first grubbing, no weeds big enough to require the second grubbing grew.

The total weight of the major weeds grubbed up the first time in hillside pasture IV was the largest. The weeds in the descending order of their fresh weights were bayabas, payang-payang babae, barak, balatong-aso, hagonoy, palis, sambong, payang-payang lalake, maguilic, lantana, aroma, suag-cabayo, poñgapong, hicaw-hicawan, and dilang-baca. The miscellaneous ones were batino, pandakáki, and dawag.

During the second grubbing, only seven of the original major weeds were present. They were bayabas, barak, payang-payang babae, hagonoy, sambong, poñgapong, and dilang-baca. Two other species became major weeds after the first grubbing, escobang babae

and kalios. The miscellaneous weeds were balatong-aso, maguilic, aroma, bansit, anonang, pandakáki, lantana, uray, palis, batino, and suag-cabayo.

There were seven major weeds collected from plain pasture IV: bayabas, payang-payang babae, payang-payang lalake, suag-cabayo, balatong-aso, hagonoy, and sambong. The miscellaneous weeds consisted of aroma, hicaw-hicawan, lantana, escobang babae, pandakáki, and dilang-baca. After the first grubbing, no weeds big enough to require second grubbing grew.

The major weeds from hillside pasture V collected during the first grubbing were: payang-payang babae, bayabas, lantana, palis, sambong, hagonoy, maguilic, payang-payang lalake, balatong-aso, and barak. The miscellaneous ones were aroma, batino, pandakáki, suag-cabayo, tadyang-calabao, kasupanguil, lagundi, and tagbac.

During the second grubbing, only six of the major weeds were present, namely, bayabas, sambong, payang-payang babae, barak, hagonoy, and lantana. Three weeds not abundant during the first grubbing became major weeds at the second. Payang-payang lalake, balatong-aso, sambong-samboñgan, and batino, composed the miscellaneous weeds.

The major weeds grubbed from plain pasture V were: bayabas, sambong, payang-payang babae, escobang babae, payang-payang lalake, suag-cabayo, and kulot-kulotan. The miscellaneous ones were aroma, balatong-aso, palis, lantana, and hagonoy. After the first grubbing, no weeds big enough to require second grubbing grew.

Table 1 shows the average weights of the major weeds gathered from a hectare of land in the five hillside pastures. The total weight of all the weeds grubbed during first grubbing from one hectare was 5,796.88 kgm., whereas the amount of major weeds obtained during the second grubbing from one hectare of pasture on the hillside was only 823.78 kgm., or about one-seventh as much as the amount removed during the first grubbing.

Table 2 shows the average weight of weeds gathered from one hectare of pasture in the plain. The total weight of the weeds removed during the first grubbing was 2,257.44 kgm. During the second grubbing, only one major weed out of the fourteen gave sufficient fresh average weights as to be considered a major species in this study. Sambong-samboñgan was not present during the first grubbing, but became a major weed during the second. The total weight of the weeds removed during the second grubbing was 211.44

kgm., or about one-eleventh as much as the weight of the weeds removed during the first grubbing.

As a whole, the first grubbing actually checked the development of the majority of the principal weeds in the hillside pastures (table 1). Out of the eighteen species, only six became major weeds during the second grubbing. On the other hand, only one of the fourteen major weeds (table 2) in the plain pasture was able to make headway in producing enough weight to be rated a major weed. One weed became of importance at the second grubbing owing perhaps to removal of competition.

If the time of grubbing should be considered very important in modifying the weed flora of the pasture, either on the hillside or in the plain, the results of this study would indicate that November and December are the best months to grub up the weeds in the plain, whereas in the hillside, no definite time could be ascertained.

Table 3 shows the average amounts of weeds grubbed up in hillside pastures I, II, III, IV, and V during the year. The average amount of weeds removed in one year from one hectare of pasture in the hillside was 6,620.66 kgm.

Table 4 shows the average weights of weeds grubbed up in plain pastures I, II, III, IV, and V during the year. The average amount of weeds removed in one year from one hectare of pasture on the plain was 2,468.88 kgm. This is about one third as much as that removed from the same area on the hillside.

### *Growth of weeds*

The average heights of the weeds are shown in tables 1 and 2. These measurements are the averages for the weeds in the hillside and plain pastures, respectively.

The data herein presented show that irrespective of the time of the first grubbing, the average height of the individual weed species was much less at the second grubbing. This can perhaps be explained from the simple physiological law of competition for light. With the removal of the weeds at the first grubbing, the weed species were given more space and an equal chance to develop; hence, the tendency to grow taller was curbed. Besides, other factors, such as water, soil, and other environmental conditions also affected the decrease in height of the major weeds after the first grubbing.

*Time and cost of grubbing the weeds*

The time consumed in removing the weeds from hillside pasture I was 205 hours during the first grubbing, which is equivalent to ₱22.55. During the second grubbing, the time consumed was 56 hours and the cost was ₱6.16. In plain pasture I, the time consumed during the first grubbing was 198 hours and the cost, ₱21.78; during the second grubbing, 52 hours; and the cost, ₱5.72. In hillside pasture II, the time was 234 hours; the cost, ₱25.74 during the first grubbing; and 44 hours with a cost of ₱4.84 during the second. In plain pasture II, the time was 229 hours which involved an expense of ₱25.19 for the first grubbing; and 45 hours at the cost of ₱4.90, for the second. In hillside pasture III it was 200 hours valued at ₱22.00. In plain pasture III, the time was 64 hours and the cost, ₱7.04. In hillside pasture IV, it was 266 hours at a cost of ₱29.26 during the first grubbing and 80 hours during the second at a cost of ₱8.80. In plain pasture IV, the time spent was 99 hours and the cost, ₱10.89. In hillside pasture V, 169 hours were consumed during the first grubbing which cost ₱18.59. During the second grubbing, the time was 70 hours and the cost, ₱7.70. In plain pasture V, the time spent was 40 hours and the cost, ₱4.40.

The averages for the hillside and plain pastures were the following: for hillside pastures (table 1), during the first grubbing, 214.8 hours at the cost of ₱23.63; during the second grubbing, 50 hours with a cost of ₱5.50. In the plain pastures (table 2), the average time spent during the first grubbing was 126 hours and the cost was ₱13.86; during the second, 19.4 hours at the cost of ₱2.13.

The yearly averages of time and cost of removing the weeds per hectare in each pasture were as follows: with the hillside pastures (table 3), the average time consumed during the year was 264.8 hours; cost, ₱29.13; in the plain pastures (table 4), an average of 145.4 hours; cost, ₱15.99.

On the whole, the amount of time consumed and the cost of removing weed species per hectare in both the hillside and plain pastures depend on the kind and number of species obtained in the area. Generally, it costs more to get rid of weeds in the hillside pastures than in the plain pastures under the conditions existing in this study in the College of Agriculture pasture grounds.

## SUMMARY AND CONCLUSIONS

1. The average weight of each kind of weed grubbed up in each of the hillside pastures in one year was: bayabas, 1,796.36 kgm.;

payang-payang babae, 1,038.35 kgm.; barak, 743.44 kgm.; lantana, 422.36 kgm.; palis, 420.18 kgm.; sambong, 395.99 kgm.; payang-payang lalake, 264.45 kgm.; hagonoy, 211.12 kgm.; suag-cabayo, 210.73 kgm.; poñgapong, 159.18 kgm.; dilang-baca, 148.46 kgm.; balatong-aso, 137.09 kgm.; maguilic, 98.73 kgm.; aroma, 90.09 kgm.; sambong-samboñgan, 82.00 kgm.; batino, 46.73 kgm.; hicaw-hicawan, 45.09 kgm.; escobang babae, 34.45 kgm., and miscellaneous weeds, 275.86 kgm. Bayabas constituted 27.1 per cent of the total amount grubbed up in the hillside pastures, which amounted to 6,620.66 kgm.

2. The average weight of each kind of weed grubbed up in each of the plain pastures in one year was: bayabas, 576.17 kgm.; sambong, 425.27 kgm.; payang-payang babae, 246.54 kgm.; payang-payang lalake, 194.11 kgm.; palis, 163.26 kgm.; balatong-aso, 159.45 kgm.; poñgapong, 102.00 kgm.; suag-cabayo, 72.18 kgm.; dilang-baca, 62.99 kgm.; escobang babae, 59.91 kgm.; sambong-samboñgan, 58.54 kgm.; pandakáki, 51.73 kgm.; uray, 30.18 kgm.; maguilic, 29.45 kgm.; barak, 25.19 kgm.; and miscellaneous weeds, 211.91 kgm. Bayabas, which was the most abundant in these pastures as it was in the hillside pastures, was 23.3 per cent of the total amount grubbed, or 2,468.88 kgm.

3. The averages of the total weight of weeds in the hillside pastures were 5,796.88 kgm. during the first grubbing and 823.78 kgm. during the second, the amount of weeds grubbed during the first grubbing being seven times as much as that during the second grubbing.

4. In plain pastures, the average total weight of weeds was 2,257.44 kgm. during the first grubbing, and 211.44 kgm. during the second, the weight of weeds grubbed up during the first operation being eleven times as great as that during the second operation.

5. The yearly average weight per hectare of all the weeds grubbed up in hillside pastures was 6,620.66 kgm. and in plain pastures, 2,468.88 kgm. The total amount of weeds grubbed up in the hillside pastures was about three times as much as that in the plain pastures.

6. The average time consumed in grubbing up the weeds in the hillside pastures per hectare in one year was 264.8 hours, which is equivalent to an average cost of ₱29.13.

7. In the plain pastures, the average time necessary to grub up the weeds was 145.4 hours per hectare during the year, at an average cost of ₱15.99.

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TABLE 1

*Average height and weight of weeds per hectare in hillside pastures*

| WEEDS | FIRST GRUBBING | | SECOND GRUBBING | |
|---|---|---|---|---|
| | Average height | Weight | Average height | Weight |
| | *cm.* | *kgm.* | *cm.* | *kgm.* |
| Bayabas | 78.6 | 1,484.36 | 39.0 | 312.00 |
| Payang-payang babae | 88.0 | 960.26 | 37.8 | 78.09 |
| Barak | 37.2 | 694.99 | 14.0 | 48.45 |
| Palis | 69.6 | 420.18 | | |
| Lantana | 105.2 | 422.36 | | |
| Sambong | 87.0 | 322.45 | 45.0 | 73.54 |
| Payang-payang lalake | 85.0 | 264.45 | | |
| Suag-cabayo | 32.0 | 210.73 | | |
| Poñgapong | 62.0 | 159.18 | | |
| Dilang-baca | 18.2 | 148.46 | | |
| Balatong-aso | 22.4 | 137.09 | | |
| Hagonoy | 22.0 | 136.38 | 13.2 | 74.74 |
| Maguilic | 39.6 | 98.73 | | |
| Aroma | 50.8 | 90.09 | | |
| Batino | 16.6 | 46.73 | | |
| Hicaw-hicawan | 23.0 | 45.09 | | |
| Escobang babae | 10.2 | 34.45 | | |
| Sambong-samboñgan | 5.4 | 31.64 | 10.4 | 50.36 |
| Miscellaneous | | 89.26 | | 186.60 |
| Total | | 5,796.88 | | 823.78 |

| | First grubbing Av./Ha. | Second grubbing. Av./Ha. |
|---|---|---|
| Time consumed in grubbing | 214.8 hrs. | 50 hrs. |
| Cost of grubbing | ₱23.63 | ₱5.50 |

TABLE 2

*Average height and weight of weeds per hectare in plain pastures*

| WEEDS | FIRST GRUBBING | | SECOND GRUBBING | |
|---|---|---|---|---|
| | Average height | Weight | Average height | Weight |
| | *cm.* | *kgm.* | *cm.* | *kgm.* |
| Bayabas | 74.0 | 576.17 | | |
| Sambong | 76.6 | 357.82 | 23.8 | 67.45 |
| Payang-payang babae | 81.8 | 246.54 | | |
| Palis | 28.0 | 163.26 | | |
| Payang-payang lalake | 77.8 | 194.11 | | |
| Balatong-aso | 28.8 | 159.45 | | |
| Poñgapong | 34.4 | 102.00 | | |
| Suag-cabayo | 62.0 | 72.18 | | |
| Dilang-baca | 14.2 | 62.99 | | |
| Escobang babae | 19.2 | 59.91 | | |
| Pandakáki | 16.8 | 51.73 | | |
| Uray | 16.8 | 30.18 | | |
| Maguilic | 15.0 | 29.45 | | |
| Barak | 17.2 | 25.19 | | |
| Samgong-samboñgan | | | 10.2 | 58.54 |
| Miscellaneous | | 126.46 | | 85.45 |
| Total | | 2,257.44 | | 211.44 |

| | *First grubbing Av./Ha.* | *Second grubbing Av./Ha.* |
|---|---|---|
| Time consumed in grubbing | 126 hrs. | 19.4 hrs. |
| Cost of grubbing | ₱13.86 | ₱2.13 |

TABLE 3

*Total of average weights of weeds from first and second grubbing in hillside pastures*

| WEEDS | WEIGHT |
|---|---|
| | *kgm.* |
| Bayabas, *Psidium guajava* Linn. | 1,796.36 |
| Payang-payang babae, *Flemingia strobilifera* (Linn.) R. Br. | 1,038.35 |
| Barak, *Curcuma zedoaria* (Berg.) Rosc. | 743.44 |
| Lantana, *Lantana camara* Linn. | 422.36 |
| Palis, *Callicarpa cana* Linn. | 420.18 |
| Sambong, *Blumea balsamifera* (Linn.) DC. | 395.99 |
| Payang-payang lalake, *Desmodium pulchellum* (Linn.) Benth. | 264.45 |
| Hagonoy, *Hyptis capitata* Jacq. | 211.12 |
| Suag-cabayo, *Hyptis suaveolens* Poir. | 210.73 |
| Poñgapong, *Amorphophallus campanulatus* (Roxb.) Blm. | 159.18 |
| Dilang-baca, *Elephantopus scaber* Linn. | 148.46 |
| Balatong-aso, *Cassia tora* Linn. | 137.09 |
| Maguilic, *Premna cumingiana* Schauer | 98.73 |
| Aroma, *Acacia farnesiana* (Linn.) Willd. | 90.09 |
| Sambong-sambongan, *Blumea lacera* (Burm. f.) DC. | 82.00 |
| Batino, *Alstonia macrophylla* Wall. | 46.73 |
| Hicaw-hicawan, *Stachytarpheta jamaicensis* (Linn.) Vahl. | 45.09 |
| Escobang babae, *Sida retusa* Linn. | 34.45 |
| Miscellaneous [a] | 275.86 |
| Total | 6,620.66 |

| | *Total av./Ha./year* |
|---|---|
| Time consumed in grubbing | 264.8 hrs. |
| Cost of grubbing | ₱29.13 |

[a] Miscellaneous weeds are given in table 1.

TABLE 4

*Total of average weights of weeds from first and second grubbing in plain pastures*

| WEEDS | WEIGHT |
|---|---|
| | *kgm.* |
| Bayabas, *Psidium guajava* Linn. | 576.17 |
| Sambong, *Blumea balsamifera* (Linn.) DC. | 425.27 |
| Payang-payang babae, *Flemingia strobilifera* (Linn.) R. Br. | 246.54 |
| Payang-payang lalake, *Desmodium pulchellum* (Linn.) Benth. | 194.11 |
| Palis, *Callicarpa cana* Linn. | 163.26 |
| Balatong-aso, *Cassia tora* Linn. | 159.45 |
| Poñgapong, *Amorphophallus campanulatus* (Roxb.) Blm. | 102.00 |
| Suag-cabayo, *Hyptis suaveolens* Poir. | 72.18 |
| Dilang-baca, *Elephantopus scaber* Linn. | 62.99 |
| Escobang babae, *Sida retusa* Linn. | 59.91 |
| Sambong-samboñgan, *Blumea lacera* (Burm. f.) DC. | 58.54 |
| Pandakaki, *Tabernaemontana pandacaqui* Poir. | 51.73 |
| Uray, *Amaranthus spinosus* Linn. | 30.18 |
| Maguilic, *Premna cumingiana* Schauer | 29.45 |
| Barak, *Curcuma zedoaria* (Berg.) Rosc. | 25.19 |
| Miscellaneous [a] | 211.91 |
| Total | 2,468.88 |

| | *Total av./Ha./year* |
|---|---|
| Time consumed in grubbing | 145.4 hrs. |
| Cost of grubbing | ₱15.99 |

[a] Miscellaneous weeds are given in table 2.

# A STUDY OF THE RELATION OF SCHOLARSHIP IN COLLEGE AND OTHER FACTORS TO INCOME OF GRADUATES [1]

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One question that is often asked is whether one's success in college, as measured by his grades, is a good index of his probable success in life. Answers to this question show a great deal of diversity. There are those who believe that too much importance is attached to marks in our educational institutions. They claim that one's ability to memorize facts from books is not a reliable index of his ability to face the problems of life, which are complex in nature and are often different from those met in classrooms and laboratories. Traits of character developed while in college, such as industry, honesty, obedience, sociability, and leadership, are factors just as important as acquisition of knowledge. On the other hand, many argue that one's performance in college during four years of stay is one of the most reliable indexes of his probable success in life. The average student is placed under the close observation of many instructors, and their grades reflect the individual's ability, earnestness, and industry. This study was conducted in order to get more information on the subject.

## *Review of literature*

Smith (1927) made mention of an investigation on the success of alumni in a large university. The successful alumni were chosen on the basis of opinion of various members of the different classes. In their choice, more stress was probably laid on professional achievement and eminence as a citizen than on success in merely making money. Another test of success employed was the inclusion of one's name in *Who's Who*. Smith found that the test by *Who's Who* is no less conclusive than the figures obtained from the committee's selection, that there is a close relation between college records and success in life, and that record in college studies is a reliable indication of success in later life.

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[1] Experiment Station contribution No. 1422.

Jones (1925) stated that younger students were doing better work in college than their older classmates, and were winning the prizes for scholarship. The average age at graduation of 1,080 individuals selected at random from *Who's Who* was 21 years and 7.5 months, while that of graduates of eleven colleges studied by Thomas (1903) was 23 years and 1.9 months. He concluded that in so far as inclusion in *Who's Who* is considered a measure of success, those who graduate from college under the median age have a greater chance of success than those whose age is above the median.

Lord (1928) studied the relation of education and income. He admitted the fact that monetary income is not the sole value of education, but he used it as the criterion in his study because income is regarded as one of the principal objectives of parents and pupils when they invest time, effort, and money in securing as high an education as possible. Furthermore, income can be measured more objectively than other returns from education, such as satisfaction, service to the community, enjoyment in acquiring knowledge or diploma. Lord presented factual evidence showing that a person with a college education has a greater chance of success in getting a better income than one without.

Sacay and Tayamen (1939) found that in the College of Agriculture, University of the Philippines, the percentage of graduation among academic high school graduates pursuing the Bachelor of Science in Agriculture curriculum ranged from 25.4 per cent to 58.3 per cent, or an average of 38.4 per cent. They further reported that, in general, a higher percentage of younger students graduated than older ones. In the case of freshmen whose age was 22 years or less, 40.6 per cent graduated. Among those whose age was 23 years or more, only 28.7 per cent graduated.

Sacay (1940) made a study of the 1911-38 graduates of the College, with particular reference to nature of occupation, earnings, marital state, and land ownership. He found that 40.1 per cent of the graduates had secondary income from other sources.

### *Objects of the study*

This investigation was conducted to determine: (*a*) the age at graduation of graduates of the College of Agriculture, University of the Philippines, (*b*) their scholarship, (*c*) earnings from

principal occupation, (*d*) total income, and (*e*) the relation of age, scholarship, and length of time that has elapsed since graduation to the earnings and total income of the graduates.

## MATERIALS AND METHODS

The graduates of the College of Agriculture, University of the Philippines, from 1921 to 1935 were included in the study. The total number of graduates during this period was 815. Of this number, complete data were secured from 472, or 58 per cent. For the rest, only partial information was available.

In 1938, information was secured by means of a questionnaire from the graduates regarding their first employment, entrance salary or initial earnings, occupation, earnings from principal occupation, income from other sources, and total income. The other phase of the work, which was done in 1939 and 1940, consisted of computing the scholarship averages of the graduates from records kept in the office of the Registrar. The weighted average grade obtained by each graduate was computed in the following manner: The final grade in each subject was multiplied by the number of units it carried. The product was termed grade-units. The total grade-units obtained during the graduate's stay in college was divided by the total units completed. The result was his weighted grade in the entire course. A subject failed was considered a separate subject with a grade of *5*. Hence, certain students graduated with averages lower than *3*.

The degree of relationship between income and various factors was presented in terms of coefficients of correlation. In computing the various coefficients, the formulae described in Garrett's book, Statistics in Psychology and Education, were used.

## RESULTS AND DISCUSSIONS

The results of the investigation are shown in tables 1 to 8.

### *Age at graduation*

The age at graduation of students in different curricula is shown in table 1. The average was as follows: Bachelor of Agriculture graduates, 25.54 years; Bachelor of Science in Agriculture, 26.31 years; and Bachelor of Science in Sugar Technology graduates, 25.48 years. There appears no noticeable tendency for students to graduate younger in later years, as might be expected.

*Scholarship of graduates*

The average grades obtained by different classes from 1921 to 1935 appear in table 2. The best average obtained by the Bachelor of Agriculture graduates was 2.69, in 1923; the poorest, 2.93, in 1935. The average of all classes was 2.79.

The Bachelor of Science in Agriculture graduates made better scholarship; the average of all classes was 2.75. The best average, 2.58, was also made in 1923; and the poorest, 2.94, in 1935.

The Bachelor of Science in Sugar Technology graduates made the best scholarship in college. The average of all classes was 2.46. The difference between this average and that of the Bachelor of Agriculture or Bachelor of Science in Agriculture graduates was statistically significant.

As may be seen in table 6, the modal grade was from 2.7 to 2.89. There were 194 cases, or 41 per cent, in this group. Only 11 per cent of the cases studied obtained average grades better than 2.5.

The students who graduated during the earlier period seem to have received slightly better grades than those in later years, as shown by the coefficient of correlation of $-.22 \pm .030$ (table 7).

Younger students received slightly better grades[2] than their older classmates. The coefficient between age at graduation and scholarship was $.28 \pm .029$. Sacay (1936) found a coefficient of $.14 \pm .104$ between age and scholarship of freshmen in the College of Agriculture.

*Initial earnings of graduates*

The first salary or initial earnings received by the graduates are shown in table 3. The average of all classes was: Bachelor of Agriculture graduates, ₱910.47; Bachelor of Science in Agriculture graduates, ₱979.00; Bachelor of Science in Sugar Technology graduates, ₱1,235.98. The differences were statistically significant.

There is a noticeable lowering in the entrance salary of graduates. Those who graduated in former years received better salaries than those in later years. The relationship is expressed by the coefficient $.48 \pm .024$ (table 7). This tendency, however, is also true of graduates from other colleges.

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[2] The highest grade in the College of Agriculture is *1* and the lowest is *5*; hence, good scholarship is represented by low numerical average.

The age of the graduates was not closely associated with entrance salary. The coefficient was only .001 ± .031 (table 7).

*Earnings from principal occupation*

The earnings from the principal occupation of Bachelor of Agriculture graduates ranged from ₱890.87 in 1935 to ₱2,186.91 in 1925. The average of all classes was ₱1,442.75. In the case of the Bachelor of Science in Agriculture graduates, the range was from ₱964.32 in 1934 to ₱2,933.33 in 1922, or an average of ₱1,571.74. The Bachelor of Science in Sugar Technology graduates made much higher earnings than either one of the two groups. The average was ₱2,739.03. The differences in average earnings among the three groups were statistically significant.

As it was to be expected, those who graduated much ahead of time generally received higher earnings than those who recently finished college. The degree of relationship is expressed by the coefficient of correlation .30 ± .029 (table 7). The coefficient was —.16 ± .030 between age at graduation and earnings.

*Total income*

In addition to their earnings from the main occupation, 33 per cent of the graduates reported income from other sources. The total yearly income is shown in table 5. The average for the Bachelor of Agriculture graduates was ₱1,617.00; Bachelor of Science in Agriculture graduates, ₱1,873.76; and Bachelor of Science in Sugar Technology graduates, ₱3,055.29. These averages are slightly higher than the earnings from the principal occupation. As is to be expected, the earlier graduates were getting higher total income than the more recent ones. The coefficient of correlation obtained was .35 ± .027 (table 7). A slightly higher coefficient, .38 ± .027, was found between initial earnings and total income. A negative coefficient, — .14 ± .031, was found between age at graduation and total income.

*Relation of scholarship and other factors to initial earnings, earnings from principal occupation, and total income*

The initial earnings are affected by the average grade, as shown in table 6. Those who obtained averages of 2.5 or better received higher amount. The relationship is expressed by a coefficient of correlation of — .24 ± .029 (table 7).

The relation of scholarship, in terms of numerical average, to earnings from the principal occupation is higher, as shown by the coefficient $-.36 \pm .027$ (table 7). Scholarship is similarly associated with total income. The coefficient of correlation obtained was $-.37 \pm .027$.

In table 8 are given partial and multiple coefficients of correlation. The number of years that had elapsed since graduation and income showed a correlation of $.35 \pm .027$, but when scholarship was held constant, the partial coefficient became $.30 \pm .028$. The coefficient between scholarship and income, with the effect of number of years since graduation partialled out, was $-.32 \pm .028$. The highest partial coefficient of the first order, $.45 \pm .025$, was obtained between number of years since graduation and entrance salary, with scholarship held constant.

The multiple coefficient between income and the following factors—number of years since graduation, entrance salary, scholarship, and age at graduation—was $.51 \pm .023$ (table 8). This low coefficient indicates that there are other factors, such as industry, family connections, opportunity, and nature of occupation, which probably play an important part in influencing income.

The linear multiple regression equation for estimating income of the alumni on the basis of the factors considered is,

$X_1 = 34.8025X_2 + .5519X_3 - 872.0561X_4 - 22.2687X_5 + 3824.23$, where $X_1$ is income, $X_2$ is number of years since graduation, $X_3$ is entrance salary, $X_4$ is scholarship expressed in average grade, $X_5$ is the age at the time of graduation, and 3824.23 is a constant. The standard error of estimate ($\sigma 1.234 =$ ₱739.75) is, however, quite big, indicating that the prediction lacks a high degree of accuracy. The value of the equation lies in showing the relative weight of each of the factors in determining income. The equation reveals the great influence of scholarship.

## SUMMARY

1. The age at graduation from the College of Agriculture of graduates from 1921 to 1935 was as follows: Bachelor of Agriculture, 25.54 years; Bachelor of Science in Agriculture, 26.31 years; Bachelor of Science in Sugar Technology, 25.48 years.

2. The average grade obtained by the graduates was: Bachelor of Agriculture, 2.79; Bachelor of Science in Agriculture, 2.75; and Bachelor of Science in Sugar Technology, 2.46. Age and scholarship showed a coefficient of correlation of $.28 \pm .029$.

3. There has been a lowering in the entrance salary of graduates, as shown by the coefficient of correlation of $.48 \pm .024$.

4. The earnings of graduates from their principal occupation were: Bachelor of Agriculture, ₱1,442.75; Bachelor of Science in Agriculture, ₱1,571.74; and Bachelor of Science in Sugar Technology, ₱2,739.03. The coefficient of correlation between scholarship and earnings was $-.36 \pm .027$.

5. The total yearly income of graduates was: Bachelor of Agriculture, ₱1,617.00; Bachelor of Science in Agriculture, ₱1,873.76; Bachelor of Science in Sugar Technology, ₱3,055.29. The coefficients of correlation between income and other factors were: scholarship, $-.37 \pm .027$; entrance salary, $.38 \pm .027$; years since graduation, $.35 \pm .027$; and age at graduation, $-.14 \pm .031$.

6. A multiple coefficient of $.51 \pm .023$ was found between income and these four factors: number of years since graduation, entrance salary, scholarship, and age at the time of graduation. Scholarship was the most important of these factors in determining income.

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TABLE 1

*Age at graduation*

| CLASS | B. AGR. | | B. S. A. | | B. S. S. T. | |
|---|---|---|---|---|---|---|
| | *number of cases* | *years* | *number of cases* | *years* | *number of cases* | *years* |
| 1921 | 28 | 25.10 | 7 | 25.14 | — | — |
| 1922 | 39 | 26.79 | 8 | 26.87 | — | — |
| 1923 | 25 | 25.72 | 15 | 25.80 | — | — |
| 1924 | 21 | 24.47 | 13 | 27.00 | — | — |
| 1925 | 38 | 24.92 | 10 | 27.10 | 4 | 27.00 |
| 1926 | 22 | 25.31 | 7 | 26.85 | — | — |
| 1927 | 27 | 25.29 | 16 | 26.81 | 5 | 25.40 |
| 1928 | 27 | 25.40 | 11 | 25.72 | 3 | 27.00 |
| 1929 | 25 | 25.36 | 16 | 27.75 | 6 | 26.50 |
| 1930 | 23 | 26.69 | 20 | 25.35 | 5 | 26.60 |
| 1931 | 20 | 27.25 | 24 | 25.75 | 13 | 25.07 |
| 1932 | 26 | 24.76 | 36 | 26.61 | 7 | 24.57 |
| 1933 | 19 | 25.57 | 59 | 25.93 | 5 | 24.20 |
| 1934 | 22 | 25.32 | 70 | 26.41 | 7 | 24.14 |
| 1935 | 25 | 25.20 | 46 | 25.69 | 8 | 24.37 |
| Total | 387 | — | 358 | — | 63 | — |
| Class average | — | 25.54 | — | 26.31 | — | 25.48 |

TABLE 2

*Scholarship of the College of Agriculture graduates*

| CLASS | B. AGR. | B. S. A. | B. S. S. T. |
|---|---|---|---|
| 1921 | 2.74 | 2.78 | — |
| 1922 | 2.77 | 2.65 | — |
| 1923 | 2.69 | 2.58 | — |
| 1924 | 2.71 | 2.62 | — |
| 1925 | 2.74 | 2.62 | 2.44 |
| 1926 | 2.80 | 2.77 | — |
| 1927 | 2.74 | 2.70 | 2.56 |
| 1928 | 2.79 | 2.73 | 2.32 |
| 1929 | 2.82 | 2.77 | 2.48 |
| 1930 | 2.75 | 2.76 | 2.50 |
| 1931 | 2.84 | 2.82 | 2.48 |
| 1932 | 2.84 | 2.85 | 2.39 |
| 1933 | 2.79 | 2.82 | 2.36 |
| 1934 | 2.86 | 2.87 | 2.67 |
| 1935 | 2.93 | 2.94 | 2.48 |
| Class average | 2.79 | 2.75 | 2.46 |

TABLE 3

*Initial earnings of graduates*

| CLASS | B. AGR. | | B. S. A. | | B. S. S. T. | |
|---|---|---|---|---|---|---|
| | *number of cases* | *pesos* | *number of cases* | *pesos* | *number of cases* | *pesos* |
| 1921 | 17 | 995.29 | 7 | 1,645.71 | — | — |
| 1922 | 22 | 1,142.72 | 4 | 810.00 | — | — |
| 1923 | 10 | 1,140.00 | 11 | 938.81 | — | — |
| 1924 | 12 | 1,080.00 | 10 | 1,116.00 | — | — |
| 1925 | 19 | 1,127.36 | 4 | 1,020.00 | 2 | 1,560.00 |
| 1926 | 15 | 1,122.66 | 3 | 1,200.00 | — | — |
| 1927 | 9 | 973.33 | 9 | 1,213.33 | 2 | 1,800.00 |
| 1928 | 17 | 974.11 | 4 | 1,250.00 | 1 | 1,500.00 |
| 1929 | 14 | 944.57 | 8 | 1,095.00 | 6 | 1,400.00 |
| 1930 | 12 | 824.66 | 7 | 940.00 | 4 | 1,260.00 |
| 1931 | 14 | 785.14 | 14 | 700.28 | 7 | 1,056.42 |
| 1932 | 15 | 604.06 | 23 | 808.00 | 3 | 1,060.00 |
| 1933 | 8 | 561.00 | 33 | 672.50 | 3 | 680.00 |
| 1934 | 16 | 590.75 | 45 | 588.66 | 5 | 1,032.00 |
| 1935 | 17 | 771.41 | 33 | 686.72 | 7 | 1,011.42 |
| Total | 217 | — | 215 | — | 40 | — |
| Class average | — | 910.47 | — | 979.00 | — | 1,235.98 |

TABLE 4

*Earnings from principal occupation*

| CLASS | B. AGR. | B. S. A. | B. S. S. T. |
|---|---|---|---|
| | *pesos* | *pesos* | *pesos* |
| 1921 | 1,715.73 | 2,425.71 | — |
| 1922 | 1,788.63 | 2,933.33 | — |
| 1923 | 1,343.33 | 1,743.63 | — |
| 1924 | 1,743.33 | 1,622.00 | — |
| 1925 | 2,186.91 | 1,550.00 | 4,500.00 |
| 1926 | 1,689.33 | 1,380.00 | — |
| 1927 | 1,675.50 | 1,301.42 | 5,350.00 |
| 1928 | 1,306.05 | 2,599.00 | 2,400.00 |
| 1929 | 1,266.23 | 1,218.75 | 1,880.00 |
| 1930 | 1,155.16 | 1,310.00 | 2,700.00 |
| 1931 | 1,356.66 | 1,099.06 | 2,371.42 |
| 1932 | 1,314.33 | 1,149.88 | 2,050.00 |
| 1933 | 1,212.50 | 1,176.83 | 2,726.66 |
| 1934 | 996.68 | 964.32 | 1,848.00 |
| 1935 | 890.87 | 1,102.22 | 1,564.28 |
| Class average | 1,442.75 | 1,571.74 | 2,739.03 |

TABLE 5

*Total yearly income*

| CLASS | B. AGR. | B. S. A. | B. S. S. T. |
|---|---|---|---|
| | *pesos* | *pesos* | *pesos* |
| 1921 | 1,986.40 | 2,797.14 | — |
| 1922 | 2,301.78 | 3,700.00 | — |
| 1923 | 1,542.22 | 2,140.90 | — |
| 1924 | 2,030.83 | 1,811.00 | — |
| 1925 | 2,396.47 | 1,625.00 | 5,500.00 |
| 1926 | 1,896.00 | 1,580.00 | — |
| 1927 | 1,964.50 | 1,715.71 | 6,350.00 |
| 1928 | 1,404.29 | 2,999.00 | 2,400.00 |
| 1929 | 1,373.92 | 1,416.25 | 2,144.00 |
| 1930 | 1,196.83 | 2,093.33 | 3,125.00 |
| 1931 | 1,420.00 | 1,120.06 | 2,442.85 |
| 1932 | 1,351.00 | 1,405.65 | 2,150.00 |
| 1933 | 1,262.50 | 1,449.72 | 2,726.66 |
| 1934 | 1,171.87 | 1,138.97 | 2,118.00 |
| 1935 | 956.50 | 1,113.80 | 1,596.43 |
| Class average | 1,617.00 | 1,873.76 | 3,055.29 |

TABLE 6

*Relation of scholarship to initial earnings, earnings from main occupation, and total income*

| AVERAGE GRADE | NUMBER OF CASES | INITIAL EARNINGS | EARNINGS FROM PRINCIPAL OCCUPATION | TOTAL INCOME |
|---|---|---|---|---|
| | | *pesos* | *pesos* | *pesos* |
| 1.5 and below | 1 | 480.00 | 4,200.00 | 4,200.00 |
| 1.7 — 1.89 | 4 | 1,065.00 | 2,862.50 | 3,192.50 |
| 1.9 — 2.09 | 10 | 1,181.60 | 2,529.60 | 3,009.60 |
| 2.1 — 2.29 | 13 | 1,149.23 | 2,284.61 | 2,851.92 |
| 2.3 — 2.49 | 25 | 1,047.27 | 2,242.60 | 2,358.60 |
| 2.5 — 2.69 | 87 | 941.03 | 1,571.46 | 1,877.20 |
| 2.7 — 2.89 | 194 | 924.11 | 1,438.02 | 1,613.81 |
| 2.9 — 3.09 | 118 | 759.16 | 1,099.76 | 1,232.94 |
| 3.1 — 3.29 | 18 | 570.88 | 1,027.00 | 1,109.50 |
| 3.3 and above | 2 | 480.00 | 600.00 | 907.50 |

TABLE 7

*Gross correlations between various factors considered*

| FACTORS | r | $PE_r$ |
|---|---|---|
| r12—number of years since graduation and total income | .35 | .027 |
| r13—initial earnings and total income | .38 | .027 |
| r14—scholarship (numerical average) and total income | —.37 | .027 |
| r15—age at graduation and total income | —.14 | .031 |
| r23—number of years since graduation and initial earnings | .48 | .024 |
| r24—number of years since graduation and scholarship (numerical average) | —.22 | .030 |
| r25—number of years since graduation and age at graduation | .001 | .031 |
| r34—scholarship (numerical average) and initial earnings | —.24 | .029 |
| r35—age and initial earnings | .01 | .031 |
| r45—scholarship and age at graduation | .28 | .029 |
| r26—number of years since graduation and earnings | .30 | .029 |
| r36—initial earnings and earnings from principal occupation | .38 | .027 |
| r46—scholarship and earnings | —.36 | .027 |
| r56—age at graduation and earnings | —.16 | .030 |

TABLE 8

*Partial and multiple coefficients of correlation between factors considered*

| FACTORS[a] | COEFFICIENT | PE |
|---|---|---|
| r12.4 | .30 | .028 |
| r13.2 | .25 | .029 |
| r13.4 | .32 | .028 |
| r14.2 | —.32 | .028 |
| r15.2 | —.15 | .030 |
| r15.4 | —.04 | .031 |
| r23.4 | .45 | .025 |
| r25.4 | .07 | .031 |
| r34.2 | —.16 | .030 |
| r35.2 | .01 | .031 |
| r35.4 | .08 | .031 |
| r45.2 | .29 | .028 |
| r12.45 | .30 | .028 |
| r13.45 | .33 | .028 |
| r14.23 | —.29 | .028 |
| r15.23 | —.16 | .030 |
| r23.45 | .45 | .025 |
| r45.23 | .29 | .028 |
| r12.453 | .18 | .030 |
| r13.452 | .23 | .029 |
| r14.235 | —.26 | .029 |
| r15.234 | —.08 | .031 |
| R1.2345 | .51 | .023 |

[a] 1, income; 2, years from graduation; 3, entrance salary; 4, scholarship; 5, age at graduation.

# TWO ADDITIONAL INSECT VECTORS OF MOSAIC OF ABACÁ, OR MANILA HEMP PLANT, AND TRANSMISSION OF ITS VIRUS TO CORN [1]

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WITH ONE PLATE

The transmission of the mosaic of abacá by *Aphis gossypii* Glover, and by two other species of aphids was reported by Ocfemia and Celino in 1938. Two years later, Celino (1940) described the transmission of the disease by *Aphis gossypii* and by *Rhopalosiphum nympheae* (Linné) and the failure of *Pentalonia nigronervosa* Coq. to communicate the disease. The transmission of the disease by more than one species of aphids stimulated search for other species of insects that can carry the virus not only to abacá but to other plants as well. The experiments reported in this paper were conducted inasmuch as the success of controlling abacá mosaic is conditioned by a knowledge of the range of suscepts of its virus and of the agents for spreading this virus.

## TRANSMISSION OF THE DISEASE BY ADDITIONAL VECTORS

All transmission experiments described in this paper were conducted with the use of young healthy abacá seedlings grown from seeds. The method described by Ocfemia (1930) for transmitting bunchy-top of abacá and followd by Ocfemia and Celino in 1938, and by Celino in 1940 was used throughout the work.

### *Experiments with Aphis maidis Fitch.*[2]

In August, 1940, large numbers of *Aphis maidis* Fitch. were noted on the young leaves of abacá seedlings in the Department of Plant Pathology. Presumably, the aphids came from the corn plants which were a few meters distant from the abacá cultures. As the aphids colonized on abacá leaves, their ability to transmit the virus of abacá mosaic was tested.

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[1] Experiment Station contribution No. 1423. Read before the Los Baños Biological Club on February 27, 1941.

[2] The insects used in the transmission experiments were determined by the Department of Entomology, College of Agriculture.

*Experiment. 1.* From August 22 to October 7, 1940, six healthy, five-month old abacá seedlings were used for colonizing the aphids which were previously allowed to feed on mosaicked abacá for two to three days. Fifty virus-laden aphids were transferred to each plant. The same number of aphids taken from corn but reared on healthy abacá for 24 to 72 hours were transferred to six healthy seedlings for control.

The aphids were left on the experimental and control plants for five days, and were killed either by spraying them with soap solution or by picking and crushing them between the fingers. The plants with the aphids were bagged until the first noticeable symptom of mosaic was noted.

All abacá plants on which virus-laden *A. maidis* were colonized showed infection with mosaic in less than two weeks. The periods of incubation of the disease ranged from eight to twelve days. The check plants remained healthy until the end of the experiment.

*Experiment 2.* From November 2 to 4, 1940, fifty *Aphis maidis* were transferred to each of two healthy, three-month old and two healthy, five-month old abacá seedlings. Four other abacá seedlings with corn aphids reared on healthy abacá were used as control.

Symptoms of infection were noted on the leaves of the experimental plants after eight days. The four abacá seedlings on which the virus-laden aphids were allowed to feed developed mosaic in eight to fifteen days. No infection was shown by any of the control plants.

It is of interest to note that *A. maidis* is widely distributed and it can exist on a large number of host plants, especially on grasses. From these hosts, its transfer to abacá is rather easy. Because of this and its ability to transmit the mosaic virus, *Aphis maidis* may perhaps be regarded as an important vector of abacá mosaic in the field.

*Experiments with Rhopalosiphum sp.*[3]

In the summer of 1940, two plants in one of the hills of abacá which the Department of Plant Pathology collected from Paete, Laguna in 1936, were infected with mosaic. Early in June, 1940, several other plants of another hill also showed mosaic. The presence of mosaic in these plants was surprising because they had not been used in any transmission experiment. As mosaic has never been reported on abacá in Paete, it was certain that the disease could not

[3] According to Dean L. B. Uichanco, this species of *Rhopalosiphum* is near *prunifoliae* Fitch.

have come with the original planting materials. It was therefore suspected that either *Aphis gossypii* or *Rhopalosiphum nympheae* from diseased abacá have migrated to these plants and effected transmission of the disease. A search for these aphids on the abacá and other plants immediately around the abacá plants failed to reveal their presence. Instead of these, two colonies of *Rhopalosiphum* sp. were found on the young shoots of kulape (*Paspalum conjugatum* (Berg.), kawad-kawad (*Synodon dactylon* Pers.), and other grasses nearby. The occurrence of the aphids on the grasses was indicated by the presence of large numbers of ants (*Dolichoderus bituberculatus* Mayr.).[4]

The spread of abacá mosaic in abacá cultures when no insects other than the grass aphid (*Rhopalosiphum* sp.) was present in large numbers suggested possible transmission of the disease by this aphid. For this reason, transmission experiments were conducted by using *Rhopalosiphum* sp. as vector.

*Experiment 1.* Four healthy, three-month old abacá seedlings were used in transmission experiments from August to September, 1940. On August 27, fifty individuals of *Rhopalosiphum* sp. which had fed on mosaicked abacá for 24 to 48 hours were transferred to each of two abacá seedlings. Two other seedlings were similarly treated on September 12. In each of the tests included in this experiment, control seedlings were used. On the control, aphids taken from grasses and allowed to feed on healthy abacá were colonized. The infective aphids were allowed to feed on the experimental abacá plants for five days, and the plants with the aphids on them were bagged until the first noticeable symptom of mosaic was noted.

In the first experiment, one hundred per cent of infection was obtained after periods of incubation ranging from nine to fifteen days. All control plants remained healthy throughout the experiment.

*Experiment 2.* Nine healthy, three-month old abacá seedlings were used for colonizing the virus-laden *Rhopalosiphum* sp. In addition to the nine seedlings, one abacá plant was used in transmission work on October 30, and three plants on November 1, 1940. In the second experiment, one hundred per cent of infection was again obtained with periods of incubation ranging from seven to thirteen days.

The results of these two experiments prove that the grass aphid (*Rhopalosiphum* sp.) is capable of transmitting the abacá mosaic

[4] Determination by Dr. S. M. Cendaña, of the Department of Entomology.

disease. It is of interest to note that in these two experiments, the symptoms in the early and in the advanced stages of infection (pl. 1, figs. 1 and 2) were very similar to those obtained with the use of *Aphis gossypii* and *Rhopalosiphum nympheae* which were described by Celino (1940) in an earlier paper.

Species of the genus *Rhopalosiphum*, especially *R. prunifoliae* Fitch. and *R. nympheae* (Linné), have been reported in the United States, Great Britain, and Japan (Patch, 1938). Probably they are also widely distributed in the Philippines. The general distribution in the Philippines seems probable because the grass hosts of these aphids are commonly found in any field in this country. As these aphids are effective carriers of the abacá-mosaic virus, their presence in localities where the mosaic disease of abacá occurs is fraught with danger.

*Failure of Aphis laburni Kaltenbach to transmit the disease*

*Experiment 1.* From September 6 to 26, 1940, six healthy, four- to five-month old abacá seedlings were used in transmission experiments with *Aphis laburni* as the vector. Fifty individuals taken from mosaicked abacá were transferred to each plant. Checks were provided and both the experimental plants and the checks were bagged.

The results obtained from this experiment were negative. All the plants appeared healthy when they were examined on January 13, 1941.

*Experiment 2.* Another experiment performed on December 15, 1940, when five healthy abacá seedlings for colonizing the aphids from mosaicked abacá were used likewise failed to produce infection.

*Failure of Pentalonia nigronervosa Coq. to transmit abacá mosaic*

Calinisan (1934), Ocfemia and Celino (1938), and Celino (1940) failed to transmit abacá mosaic with the use of *Pentalonia nigronervosa* Coq. as the vector.

According to Magee (1930), the Australian chlorosis, or heart rot of banana, may be transmitted by *Pentalonia nigronervosa.* In 1940, however, the same author stated that he confirmed the transmission of the banana mosaic by this aphid only with difficulty so he regarded *Pentalonia nigronervosa* as an unsteady vector and, therefore, probably of not much importance in the field. Calinisan in 1938 concluded that "...*P. nigronervosa* seems to have some relation with

the transmission of abacá mosaic" although his claim was not supported by experiments.

Owing to the fact that other species of aphids have been able to communicate the disease not only from abacá to abacá but also to plants belonging to different families, the relation of *Pentalonia nigronervosa* to the spread of mosaic disease of abacá was further studied.

*Experiment 1.* From September 4 to December 24, 1940, seven healthy, two- to three-month old abacá seedlings were used for colonizing *P. nigronervosa* which were reared on mosaicked abacá. On September 4, twenty-five aphids were transferred to each of three young abacá seedlings. The plants were bagged and the aphids were left on the plants for an indefinite period. On September 13, twenty-five aphids from mosaicked abacá were transferred to each of two other abacá seedlings. Twenty-five aphids were also placed on each of two other abacá seedlings on September 23. The same number of aphids were placed on each of two abacá seedlings on October 8 and on October 15.

Although the abacá seedlings used in these trials were much younger than those used by Celino (1940) in his experiments and, therefore, they are more susceptible to infection than the older plants, the abacá seedlings did not show infection when examined on December 13, 1940, and on January 31, 1941.

*Experiment 2.* On October 8, fifty aphids taken from mosaicked abacá were placed on each of the four healthy, two- to three-month old abacá seedlings.

The results of this experiment were likewise negative. All the plants appeared healthy on January 31, 1941. These findings differ from those of Magee (1930, 1940), and Calinisan (1938), but they confirm the results obtained by Ocfemia and Celino (1938) and by Celino (1940) in earlier experiments.

The failure of *Pentalonia nigronervosa* to transmit the abacá mosaic in repeated experiments is of importance. The presence of this aphid in large numbers on abacá and on banana should not be a cause for worry unless bunchy-top is prevalent in the locality.

## TRANSMISSION OF ABACÁ MOSAIC TO CORN

As the mosaic of abacá was successfully transmitted to abacá by *Aphis maidis*, it was thought that the disease might possibly infect corn also. For that reason, transmission experiments were conducted

by using healthy young corn seedlings of Calauan Yellow Flint for colonizing the aphids which had been allowed to feed on mosaicked abacá.

*Experiment 1.* Twelve seedlings were used from September 5 to October 3, 1940, with thirty infective *A. maidis* on each seedling. The plants were bagged for two days, but the aphids were allowed to remain on the corn plants until infection was apparent.

Of these twelve plants, nine manifested mosaic and three did not. The periods of incubation ranged from four to thirteen days.

*Experiment 2.* The experiment was repeated on October 12, 1940, by using seven corn seedlings for colonizing viruliferous individuals of *A. maidis.* Of these plants, four showed mosaic with periods of incubation ranging from five to fourteen days.

The writers noted that the artificially infected corn seedlings showed irregular light areas, or mottled appearance, at the base of the young expanded leaves, as in true corn mosaic (pl. 1, figs. 3 and 4). As the plants grew older, the light yellowish streaks became less distinct. As a whole, the leaves appeared pale or much lighter green than those of healthy plants. The plants were stunted in growth and produced abnormally small-sized ears with but few kernels. It seems that the disease is not seed-borne because none of the 37 corn seedlings which were grown from kernels produced by the mosaicked plants showed symptoms of mosaic.

### RECOVERY OF THE ABACÁ MOSAIC VIRUS FROM CORN

*Experiment 1.* On October 24, 1940, fifty to sixty individuals of *Aphis maidis* from artificially infected corn were transferred to each of four healthy abacá seedlings. The plants were bagged and checks consisting of two healthy abacá seedlings with non-viruliferous aphids were provided.

All of the four plants showed mosaic; three after incubation periods ranging from 11 to 22 days, and one after 76 days.

*Experiment 2.* Another experiment was conducted on October 25 and 28, 1940, by using seven young corn seedlings as experimental plants instead of abacá for colonizing the aphids which had been allowed to feed on mosaicked corn.

Of the seven experimental plants, four became infected with mosaic but three did not. The periods of incubation ranged from five to fifteen days. These results indicate that corn may be infected with abacá mosaic. In 1938, Ocfemia and Celino, and in 1940,

Celino successfully transmitted abacá mosaic virus to the wild *Canna indica* Linn. from Davao. Owing to the fact that the abacá mosaic virus is readily communicated to several other plants outside of the genus *Musa* and the virus remains virulent after passage through these host plants, the presence of these susceptible plants near abacá plantations in which mosaic is present should always be regarded with suspicion. The transfer of planting materials such as rootstocks of *Canna,* abacá corms and suckers, and green corn plants for forage purposes from mosaic-infected to uninfected localities would be dangerous. These materials will carry both the disease and the insect vectors.

## DISCUSSION OF RESULTS

Although abacá mosaic is readily transmitted by *Aphis gossypii, Rhopalosiphum nympheae, Rhopalosiphum* sp., and *Aphis maidis,* the writers failed to effect transfer of the virus with the use of *Pentalonia nigronervosa* Coq., the vector for abacá bunchy-top (Ocfemia, 1926). *Aphis maidis* is not only capable of communicating mosaic from abacá to abacá but it is also able to infect corn with the abacá mosaic. Although *Aphis gossypii* could infect *Canna indica* Linn. with abacá mosaic, and *Aphis maidis* could transmit abacá mosaic to corn, the writers have not been able to effect transmission of the disease to any of our cultivated bananas. In an earlier paper, Celino (1940) attributed his failure to transmit the mosaic of abacá to the banana to inability of the aphid to gain a foothold on the bloomed surface of banana petioles and leaves.

The fact that *Pentalonia nigronervosa* cannot transmit abacá mosaic although it is the only known vector for bunchy-top seems to find a parallel in some virus diseases. The work of Ocfemia and Buhay (1934) shows that there is a specific relationship existing between *Pentalonia nigronervosa* and the bunchy-top of abacá. In the curly-top of sugar beets, the leafhopper *Eutettix tenellus* Baker can readily transmit the disease but other beet insects cannot effect transmission (Ball, 1909). The sugar beet mosaic is readily transmitted by the peach aphid (*Myzus persiceae* Sulzer), but not by the beet leafhopper (Robbins, 1921). *Aphis sacchari* Zehnt. which lives on sugar cane is not able to transmit grass mosaic, but *Aphis maidis,* which will thrive on sugar cane only for a few days readily transmits the disease (Kunkel, 1924). Several other cases may be cited in which there seems to be some specific relationship between the virus and the vector

as well as examples of viruses which are capable of being transmitted by more than one species of insect vector.

Perhaps, it seldom, if ever, occurs in nature that *Aphis maidis* would feed on abacá so that it can be regarded as a natural carrier of infection. Likewise it seldom, if ever, occurs that abacá mosaic is transmitted to corn in the field. The results here presented may merely indicate what results may be obtained experimentally and under controlled conditions rather than point to actual finding of new insect vector and of new hosts susceptible to infection with the virus.

In his studies of the host range of the southern celery mosaic, Wellman (1935) successfully transferred the virus to *Zea mays* Linn., *Secale cereale* Linn., and other members of the family Gramineae. Price (1940) listed the graminicolous hosts of the cucumber-mosaic virus and showed graphically the comparative host ranges of six plant viruses. The writers believe that the transmission of the abacá-mosaic virus to corn indicates that the abacá-mosaic virus is allied to *Marmor cucumeris* Holmes (1939), or *Murialba cucumeris* Valleau (1940), of the cucumber-mosaic group.

## SUMMARY

1. In addition to *Aphis gossypii* Glover and *Rhopalosiphum nympheae* (Linné), *Aphis maidis* Fitch. and a species of *Rhopalosiphum* (near *prunifoliae* Fitch.) collected from grasses can transmit abacá mosaic. The periods of incubation of the disease with *Aphis maidis* as the carrier ranged from eight to fifteen days; and with the aphid from the grass, seven to fifteen days.

2. The mosaic disease of abacá could not be transmitted by *Aphis laburni* Kaltenbach and *Pentalonia nigronervosa* Coq.

3. Successful transfer of the virus to corn was accomplished by *Aphis maidis* in four to thirteen days. The inoculum was recovered from corn by corn aphids, and the virus thus recovered proved to be still infectious to abacá and corn seedlings.

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PLATE I

Leaves of abacá seedlings showing (1) symptoms of mosaic disease in the advanced stage of infection, and (2) symptoms in the early stage of the disease. (3) Portions of leaves of corn seedlings with abacá mosaic showing long, more or less broad irregular stripes from the base to the tip of the foliage, and (4) small irregular mottling characteristic of grass mosaic. (5) Appearance of the leaf of a healthy corn plant, the check. Photograph by the Photographic Division, College of Agriculture.

## COLLEGE AND ALUMNI NOTES

Dean Leopoldo B. Uichanco was the speaker at the special convocation of the student body of Rizal High School, Pasig, Rizal, on March 17.

Dr. Miguel Manresa delivered the commencement address at Batac Rural High School, Batac, Ilocos Norte, on March 29.

Dr. José M. Capinpin was the graduation speaker at the commencement exercises at Eastern Rizal Academy High School, Morong, Rizal, on March 25.

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The Society for the advancement of Research held its fifteenth initiation exercises on February 17, 1941. Professor H. H. Bartlett of the University of Michigan was the guest speaker.

Glicerio M. Garcia, Prayul Siddhijai, and Luciano E. Lactao were initiated as associate members; Dr. Nicolas L. Galvez, Professor Calixto Mabesa, Professor Emiliano F. Roldan, Dr. Julian Banzon, Dr. Joaquin Marañon, Vice-President Hermenegildo B. Reyes, and Dr. Agustin Rodolfo as active members.

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Dean and Mrs. Leopoldo B. Uichanco entertained the graduates at a despedida party at Molawin Hall on March 14, 1941.

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The following papers were read and discussed before the Los Baños Biological Club meeting on January 30, 1941:

Dr. M. Mondoñedo. One year operation of the College of Agriculture swine herd.

Dr. F. M. Sacay. The relation of grades in College and other factors to earnings after graduation.

The following papers were presented before the meeting on February 27, 1941:

Dr. F. M. Fronda, Mr. L. P. Zialcita, and Mr. E. Basio. Broom corn seeds as a grain feed for layers.

Mr. M. S. Celino. Further studies on abacá mosaic:
II. Two other aphid vectors of the virus and its transmission to corn.

Dr. S. M. Cedaña. Observations on some pests in Mindanao.

The tenth commencement exercises of the U. P. Rural High School were held on March 22, 1941. Dr. Cecilio Putong, Superintendent of City Schools in Manila, was the guest of honor. Dr. Bienvenido M. Gonzalez, President of the University of the Philippines, distributed the diplomas and certificates.

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The graduation of the following was approved by the College faculty on March 14:

For the degree of Bachelor of Science in Agriculture (39):

1. Gerardo L. Aquino
2. Juan A. Ariaga
3. Nicolas C. Camello
4. Ildefonso E. Cruz
5. Hipolito A. Custodia
6. Alfonso J. Damian
7. Wilfrido G. Dayrit
8. Rafael J. Durban
9. Silverio M. Fontillas
10. Rufino S. Gachalian
11. Glicerio M. Garcia
12. Amador T. Gervacio
13. Rizalino G. Gilpo
14. Luciano E. Lactao
15. Porfirio T. Lazaro
16. Diosdado D. Leyson
17. Pastor V. Manalo
18. Crisostomo M. Marasigan
19. Higino R. Marquez
20. Aguedo P. Martir
21. Salvador C. Monje
22. Hugo V. Olviga
23. Pang Kwok Kee
24. Celso R. Parcon
25. Victoriano C. de la Paz
26. Saturnino S. Posadas
27. Ambrosio H. Ramos
28. Rafael G. Ramos
29. Francisco G. Rentutar
30. Bruno M. Santos (*Baker memorial scholar*)
31. Paterno R. Santos
32. Prayul Siddhijai (*Cum laude*)
33. Celso S. Songcuya
34. Praves Sribhibhadhna
35. Outai Thoonkapbalin
36. Vicente C. Ureta
37. Francisco D. Virtucio
38. Moises Q. Visperas
39. Boonsri Wangsai

For the degree of Bachelor of Science in Sugar Technology (2):

1. Federico T. Lazaro
2. Irineo M. Olalia

For the Certificate in Agricultural Education (3):

1. Luciano E. Lactao
2. Chan Meesukh
3. Praves Sribhibhadhna

For the title of Associate in Agriculture (6):

1. Vicente S. Cruz
2. Florentino P. Elicaño
3. Teodulfo C. Limas
4. Ludovico T. Obsequio
5. George B. Russell
6. Armando C. Siason

The aforementioned students together with those whose graduation was approved by the College faculty at its meeting on October 15, 1940, were awarded their diplomas at the University commencement exercises on March 25.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

The undersigned, College of Agriculture, University of the Philippines, publisher or owner of THE PHILIPPINE AGRICULTURIST, published monthly for ten months in Los Baños, province of Laguna, after having been duly sworn in accordance with law, hereby submits the following statement of ownership, management, circulation, etc., which is required by Act 2580, as amended by Commonwealth Act 201:

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L. B. UICHANCO
*Dean, College of Agriculture*

Subscribed and sworn to before me this 18th day of March, 1941, at Los Baños, province of Laguna.

SILVIO A. LOPEZ
*Municipal Mayor*